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EFFECTS OF LAKE MICHIGAN DIVERSION ON THE WATER CHEMISTRY OF THE ILLINOIS WATERWAY

by Donald H. Schnepper, Robert Sinclair, V. Kothandaraman, and Ralph Evans

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BACKGROUND

The United States Congress authorized under Section 166 of the Water Resources Development Act of 1976 (P. L. 94-587) a five-year Lake Michigan diversion demonstration program designed to evaluate the feasibility of increasing the average annual diversion from the present limit of 3200 cubic feet per second (cfs) to 10,000 cfs. The primary objectives of the demonstration program are twofold: 1) to mitigate water damage on the shoreline of Lake Michigan and other Great Lakes during periods of abnormally high water levels in the Great Lakes and 2) to improve the water quality of the Illinois Waterway. The diversion demonstration program was developed and administered by the U. S. Army Corps of Engineers in cooperation with the state of Illinois and the Metropolitan Sanitary District of Greater Chicago.

The authorization by Congress stipulated the criteria to be followed in implementing the diversion plan (Corps of Engineers, 1978). The broad criteria as summarized by the Army Corps are given below:

1) When the level of Lake Michigan is below its average level, the total diversion for the succeeding year shall not exceed 3200 cfs on an annual basis. The average level of Lake Michigan will be based upon the average monthly period for the period from 1900 to 1975.

2) When the river stages approach, or are predicted to approach, bankfull conditions at the established flood warning stations on the Illinois Waterway or the Mississippi River, or when further increased diversion of water from Lake Michigan would adversely affect water levels necessary for navigational requirements of the St. Lawrence Seaway in its entirety throughout the St. Lawrence River and Great Lakes-St. Lawrence Seaway, diversion shall not be increased above the existing 3200 cfs. In addition, information pertaining to the calculation of the average level of Lake Michigan, accounting year, how much and when increased diversions are allowed, etc., are summarized by the Corps of Engineers (1978).

The Corps of Engineers has the overall responsibility of assessing the impact — environmental, economic, and sociopolitical — due to the increased diversion of water from Lake Michigan into the Illinois Waterway. The work reported herein, i.e., evaluating the effects of Lake Michigan diversion on the water chemistry of the Illinois Waterway, was sponsored and funded by the Chicago District Corps of Engineers.

The principal objectives of this investigation were to develop baseline water chemistry data throughout the waterway at regular intervals prior to the start of increased diversions and to assess the probable extent and magnitude of the impact of the diverted waters on the water chemistry of the Illinois waterway.

The field work required to obtain the baseline chemical data necessitated the travel of about 4400 river miles by boat. Excluding temperature measurements made at 2-mile intervals for 16 trips, about 6600 analyses were performed. From the nature of the undertaking and the objectives, this is a data-oriented report. Considerable reliance has been placed on tables, figures, and a comprehensive appendix. In terms of the data base developed, its use for predicting the effects of Lake Michigan diversion on the chemical quality of the waterway does not represent its full potential. Its application for assessing other water quality aspects of the waterway will be pursued at a later time. Other groups are encouraged to use it also.

Illinois Waterway

The Illinois River, which is the major part of the Illinois Waterway, is formed by the confluence of

the Kankakee and Des Plaines Rivers southwest of Chicago. The river flows nearly westward to Hennepin where it turns abruptly southwest and finally empties into the Mississippi at Grafton, north of St. Louis (figure 1). The Illinois River proper is 275 miles long and the entire waterway from Lake Michigan to Grafton is about 326 miles. The waterway consists of a series of eight navigational pools created by locks and dams to maintain water depths needed for commercial barge movements. At normal river stages, the velocity of flow is less than 1 mile per hour. Major tributaries to the waterway, the locations of locks and dams, and river mile designations from the confluence of the Illinois River with the Mississippi River are also shown in figure 1.

The waterway receives discharges from such industries as petroleum refining, pulp and paper, fermentation and distillation, meat packing, metal finishing and plating, etc. There are 27 municipal sewage treatment plants discharging directly into the Illinois Waterway. The major ones among these are the Metropolitan Sanitary District of Greater Chicago and the Greater Peoria Sanitary District.

Acknowledgments

This investigation was sponsored and funded by the Corps of Engineers, Chicago District, U. S. Department of the Army. The work was performed under the general supervision and guidance of the Chief of the Illinois State Water Survey. The following State Water Survey personnel participated in this investigation: L. G. Brooks and John Crooks assisted in the field work; Dave Hullinger, Dana Shackleford, Curtis Pulliam, and Joe Vlasis performed various chemical analyses; Linda Johnson typed the initial draft; John Brother prepared the illustrations; J. Loreena Ivens and Tony Fitzpatrick edited the final manuscript; and Marilyn Innes prepared the camera copy. The Champaign District Office of the U. S. Geological Survey provided flow data for the Illinois Waterway at Marseilles, Kingston Mines, and Meredosia gaging stations and for all the tributaries.

DATA COLLECTION

In order to develop water chemistry data for the Illinois Waterway prior to increased Lake Michigan diversion, 28 river sampling stations were established covering the stretch of about 270 miles from Grafton to the confluence of the Des Plaines and Kankakee Rivers. The sampling locations were approximately 10 miles apart and were chosen to coincide with some permanent land marks such as bridges, range lights, or day markers. River mile designations for these 28 sampling locations are shown in subsequent sections of this report.

At each site, two samples were collected at a depth of 3 feet in the channel. One sample, collected with a Juday sampler, was used for the field determination of temperature and dissolved oxygen. Dissolved oxygen was measured by the modified Winkler method. The second sample was collected with a 1000-ml wide-mouthed jar attached to a pole. A portion of this sample was filtered through a 0.45 µm millipore filter. The filtrate was collected in small plastic bottles for subsequent analysis in the laboratory for ammonia, nitrate, and dissolved orthophosphate. Micropore filtration eliminates any bacterial activity which could alter the species makeup of nitrogen and phosphorus in the samples. This method of sample preservation is considered superior to acidification or other chemical additives.

The remainder of the second sample was stored in a wide-mouthed tapered glass jar of the type used in home canning. This sample was used in the laboratory for determining pH, turbidity, alkalinity, hardness, total chlorides, total and dissolved solids, and total phosphorus. Standard methods (American Public Health Association, 1976) were used in all the analyses except for ammonium-N (table 1). Dissolved solids concentrations were computed by the difference between total solids and suspended solids.

Along the 270-mile study stretch, samples were collected at 2-mile intervals for temperature determination with a thermometer. During the initial stages of this investigation, samples for temperature determinations were collected after stopping the boat. Samples were collected from the surface and from several depths at each station to define the vertical temperature profile. Because no difference

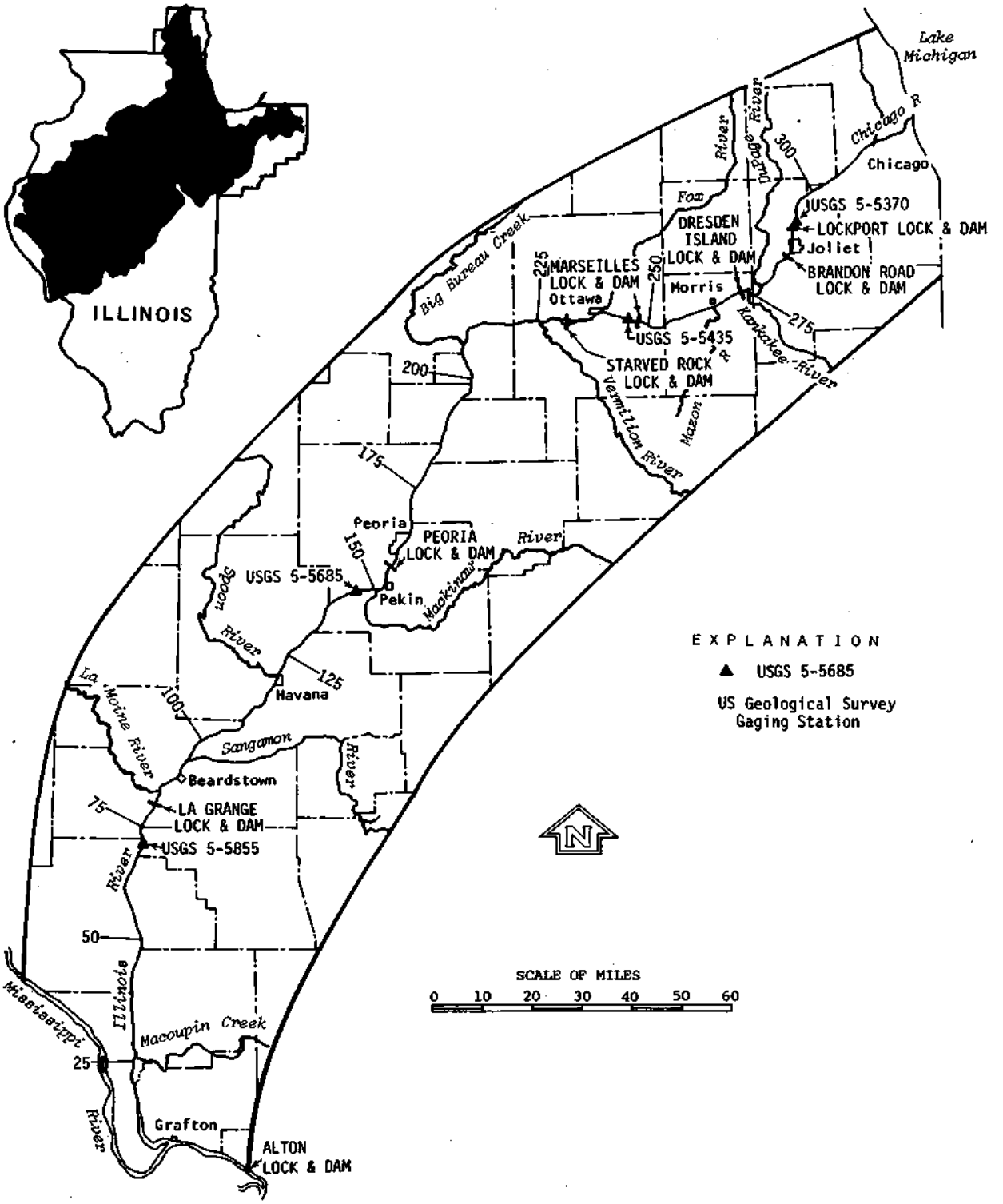

Figure 1. Illinois waterway and its tributaries

Table 1. Analytical Procedures

Turbidity	Nephelometric method, using Turner Fluorometer Model 110; Formazin was used as a standard
pH	Glass electrode method using Beckman 4500 meter
Alkalinity	Potentiometric titration to pH 4.5
Hardness	EDTA titrimetric method
Chlorides	Argentometric method
Total solids	Residue on evaporation at 103 to 105°C
Suspended solids	Filtration through Gooch crucible, with glass fiber filters and dried at 103 to 105°C
Orthophosphorus	Ascorbic acid method
Total phosphorus	Sample was digested with sulfuric-nitric acid mixtures . and determined by ascorbic acid method
Ammonium-N	Phenol-hypochlorite method (Harwood and Kuhn, 1970)
Nitrate-N	Chromotropic method

in temperature was detected at different water depths, only surface temperature samples were collected during the rest of this study. Also, because the procedure of bringing the boat to a standstill every 2 miles to collect temperature samples was time consuming, a successful technique for collecting samples while the boat was in motion was developed and adopted.

The depth and location of sampling within the waterway were selected on the basis of prior experience. Nevertheless, there were some reservations about using a 3-foot depth and confining the sampling to the channel area. The main concern was the extent of lateral and vertical dispersion as well as probable changes in a "plug" of water during its downstream passage.

A series of samples were collected throughout the accessible length of the Starved Rock pool on October 28, 1978, at two different depths and at three points on traverses while moving downstream approximately at stream velocity. The results are shown in table 2. A review of the results for each of the 13 parameters measured indicates that there is not a significant change on any of the four traverses except at river mile 239.6 on the right bank. At this location the Fox River enters the waterway at the right bank. Although there are changes in the vicinity of the confluence, the influence of the Fox River on the waterway is transitory. From these observations it is concluded that sampling at the 3-foot depth within the channel area produced results reflecting the chemical characteristics of the waterway.

Data collection started July 18, 1978, and eight river trips were made by September 26, 1978. Data collection efforts were resumed on June 5, 1979, and eight river trips were made by September 18, 1979. This provided a total of 16 observations and data points at all but a very few of the 28 locations on the main stem of the waterway.

During 1979, major tributaries to the Illinois Waterway were also included in the data collection program. Samples were collected from bridges on the tributaries on the same day the waterway samples were collected. Temperature and dissolved oxygen concentrations were determined in the field, and samples were collected for laboratory analyses of pH, alkalinity, hardness, turbidity, total chloride, total and suspended solids, ammonia-N, nitrate-N, dissolved orthophosphorus, and total phosphorus.

Tributary sampling locations were chosen close to the points of confluence with the main stem. The names and sampling sites of tributaries monitored are:

Tributary	*River mile at confluence*	*Sampling site*
Mazon River	263.6	Near Morris
Fox River	239.6	At Dayton
Vermilion River	226.3	At Jonesville
Big Bureau Creek	209.2	Rt. 29 bridge at Bureau
Mackinaw River	147.8	Near Powerton
Spoon River	120.5	Near Havana
Sangamon River	95.4	Rt. 78 bridge near Chandlerville
LaMoine River	83.7	Rt. 24 bridge near Ripley
Macoupin Creek	23.1	Near East Hardin

Table 2. Water Quality of Starved Rock Pool, October 12, 1978*

River mile	*pH*	*Alk*	*Hard*	*Turb*	*TS*	*SS*	*Cl*
244.0 R-3	7.86	164	317	9.6	516	32	63.0
244.0 R-6	7.87	166	317	8.2	519	31	60.6
244.0 M-3	7.91	164	304	15.1	514	47	63.0
244.0 M-6	7.93	164	284	12.4	506	41	58.2
244.0 L-3	7.93	164	310	6.8	509	41	63.0
244.0 L-6	7.99	164	317	13.7	508	41	58.2
242.0 M-3	7.78	168	317	12.4	495	30	58.2
239.6 R-3	8.56	250	389	6.2	476	29	38.8
239.6 R-6	8.51	248	422	5.5	470	28	33.9
239.6 M-3	7.86	162	350	12.4	462	31	58.2
239.6 M-6	7.92	164	304	11.7	455	33	58.2
239.6 L-3	7.88	164	330	13.1	473	34	58.2
239.6 L-6	7.90	164	340	11.0	482	27	58.2
237.9 M-3	7.97	176	340	13.7	485	34	55.7
236.2 R-3	8.02	185	304	18.6	483	33	53.3
236.2 R-6	8.04	185	323	11.0	517	29	53.3
236.2 M-3	8.09	185	347	11.0	445	36	46.0
236.2 M-6	8.11	187	356	13.1	477	48	48.5
236.2 L-3	8.08	185	297	8.2	448	31	46.0
236.2 L-6	8.09	185	363	10.3	445	34	48.5
234.2 M-3	7.65	172	310	19.3	497	26	48.5
231.7 R-3	8.16	180	337	22.0	543	81	48.5
231.7 R-6	8.07	170	323	25.5	551	104	48.5
231.7 M-3	8.10	178	290	15.1	517	65	48.5
231.7 M-6	8.10	180	323	13.7	507	57	50.9
231.7 L-3	8.12	185	310	17.9	509	61	48.5
231.7 L-6	8.00	176	284	21.3	518	72	48.5

Concluded on next page

The results of all chemical and physical measurements, including computed flow, are included in tabular form in the appendix. The procedures used to estimate streamflow at each of the sampling locations are described later. The tabulated data are also depicted in graphic form in the appendix, with maximum, minimum, and average values designated for each of the 13 constituents measured.

Although chemical analyses and field measurements were performed for 13 constituents, the assessment of diversion water effects was limited to six constituents, i.e., chloride, total dissolved solids, alkalinity, hardness, nitrate-nitrogen, and total phosphorus. The principal rationale for excluding pH, dissolved oxygen, ammonia nitrogen, and orthophosphorus was the fact that their concentrations are most likely influenced by biochemical reactions independent of diversion waters. Similarly, the concentration of suspended solids and turbidity units are influenced by barge traffic independent of the normal flow ranges examined. The data derived for the four biochemically mediated constituents will be used in the LaGrange Pool study as part of the effort to define the mechanisms governing the dissolved oxygen resources of that pool.

The water chemistry data developed during this investigation were used in assessing the effects of increased Lake Michigan diversion on the water chemistry of the Illinois Waterway. Two different approaches — a statistical approach and a mass balance approach — were employed in the assessment and these are dealt with in detail in the following commentary.

Table 2. Concluded

River mile	NH_4-N	$N0_3$-N	Total PO_4-P	Diss PO_4-P	Temp	DO
244.0 R-3	.87	3.31	.67	.23	14.1	5.60
244.0 R-6	.94	3.37	.69	.28	14.1	5.65
244.0 M-3	.60	3.18	.57	.19	14.0	7.50
244.0 M-6	.63	3.20	.56	.20	14.0	7.60
244.0 L-3	.75	3.31	.58	.25	14.5	7.50
244.0 L-6	.77	3.32	.60	.22	14.6	7.55
242.0 M-3	.78	3.33	.63	.24	14.7	7.00
239.6 R-3	.02	2.86	.22	.08	13.1	9.90
239.6 R-6	.01	2.88	.22	.11	13.1	9.75
239.6 M-3	.76	3.45	.58	.24	15.1	6.50
239.6 M-6	.79	3.43	.58	.28	15.1	6.50
239.6 L-3	.85	3.39	.63	.22	15.0	6.60
239.6 L-6	.76	3.41	.60	.23	15.0	6.55
237.9 M-3	.68	3.27	.56	.23	14.8	7.15
236.2 R-3	.38	3.26	.48	.25	14.9	7.70
236.2 R-6	.41	3.31	.51	.19	14.9	7.70
236.2 M-3	.44	3.29	.50	.18	14.9	7.75
236.2 M-6	.42	3.29	.50	.18	14.9	7.70
236.2 L-3	.46	3.30	.48	.19	14.9	7.90
236.2 L-6	.46	3.34	.48	.29	14.9	7.70
234.2 M-3	.43	3.33	.48	.18	14.3	7.30
231.7 R-3	.34	3.12	.57	.17	13.9	7.70
231.7 R-6	.44	3.08	.59	.20	13.9	7.70
231.7 M-3	.38	3.10	.54	.16	14.0	7.70
231.7 M-6	.38	3.05	.47	.18	13.9	7.60
231.7 L-3	.40	3.08	.51	.22	14.0	7.60
231.7 L-6	.41	3.10	.54	.14	14.0	7.60

** All values in mg/l except turbidity NTU, temperature °C, and pH*
Note. R-3 equals near right bank at 3-foot depth
M-3 equals centerline of channel at 3-foot depth
L-3 equals near left bank at 3-foot depth

IMPACT ASSESSMENT

Statistical Analysis

There are basically two methods for developing a mathematical model useful in forecasting river water quality. One is the construction of a theoretical model based on the structure of the causal chemical, biological, and physical relationships among water quality parameters. Mathematical models of this category have been developed for the interrelationship of dissolved oxygen and biochemical oxygen demand in surface waters. The second method uses the mathematical dependence among the water quality parameters on a purely statistical basis — a black box approach. In this case statistical dependence among water quality parameters does not necessarily imply causal dependence.

Several factors affect the concentrations of chemical constituents in a river system. Important factors are the geology of the watershed, rainfall, rate of runoff, land-use patterns, extent and nature of fertilizer applications in agricultural practices, in-stream biological reactions, municipal and industrial waste effluents, and other anthropogenic factors. Because the Illinois Waterway consists of a series of eight pools, with extensive flow regulation at the dams, mathematical formulation based on cause and effect relationships is extremely difficult.

Therefore, the mathematical formulations to predict the effect of diverted waters from Lake Michigan on a segment of the waterway extending from river mile (RM) 270.6 to its confluence with the Mississippi were developed solely from statistical relationships in contrast to causal interrelationships.

As mentioned earlier, for the modeling effort six chemical constituents were examined. They were chloride, total dissolved solids, alkalinity, hardness, nitrate-nitrogen, and total phosphorus. The bases for predictive expressions are the statistical relationships existing between upstream and downstream concentrations of a particular chemical constituent. For example, the chloride concentration in the waterway at river mile 260.4 bears a definite relationship to the concentration at river mile 270.6. Likewise, the chloride concentration at the next downstream sampling location (RM 250.0) is related to its upstream (RM 260.4) concentration. The influence of an upstream station is propagated downstream by the use of interstation relationships until the last downstream sampling station is reached. Once a set of equations defining the interrelationships is developed from historical data, these equations can be used to forecast the response to external stimuli, such as effluent discharges, diversion waters, etc. This approach has been reported to be successful for the Passaic River in New Jersey (Tirabassi, 1971).

The interstation relationships for each parameter were examined by the least squares curve fit technique by using the following three mathematical expressions:

$$y = a + bx \quad (1)$$

$$y = a \exp(bx) \quad (2)$$

$$y = ax^b \quad (3)$$

where

y = dependent variable (concentration of the chemical constituent at the downstream station)

x = independent variable (concentration of the chemical constituent at the immediate upstream station)

a and b = constants

The expression giving the highest coefficient of correlation was chosen to define the relationship.

The most likely forms of the equations defining the statistical interstation relationships for chloride in the waterway along with the correlation coefficients and the values for the constants a and b are shown in table 3. Similar mathematical relationships were developed for the other five chemical constituents and are shown in tables 4 through 8. Averages of six chemical constituents are shown in table 9.

Anticipated changes in the water chemistry of the Illinois Waterway due to increased Lake Michigan diversions were assessed under three different flow conditions; namely, the annual average of observed flows in the waterway during water years 1971, 1973, and 1977. The Corps of Engineers considers these flow conditions representative of average, wet, and dry flow conditions, respectively, in the waterway.

The Illinois Waterway flows are gaged by the U. S. Geological Survey at three stations: Marseilles, Kingston Mines, and Meredosia. The following includes the annual average flows (in cfs) at each gage during water years 1971, 1973, and 1977.

	1971 (average)	*1973 (wet)*	*1977 (dry)*
Marseilles	8,343	15,120	6,914
Kingston Mines	13,040	26,670	9,359
Meredosia	18,700	41,260	12,620

From these values, average annual flow values for each year were synthesized for all waterway sampling locations. For waterway locations between the gaging stations, incremental flow factors expressed as cubic feet per second per river mile were computed by using the differences in the observed average flow values at the gaging stations and dividing this value by the river mile distance between gaging stations. The flow factor computed for the stretch between Kingston Mines and Meredosia was used for the stretch downstream of Meredosia. Likewise, the flow factors computed for the stretch between Kingston Mines and Marseilles were used forthe waterway stretch upstream of Marseilles. The computed annual mean flows in the Illinois Waterway at all stations for 1971, 1973, and 1977 are given in table 10. These are the annual mean flows likely to be representative of the average, wet, and dry flow conditions in the waterway.

The use of annual mean water year flows as the flow regime of the waterway to which Lake Michigan water would be applied admittedly produces conservative results compared with selecting the low flow periods (July-October) for each of the three years as the flow regime of the waterway.

Table 3. Illinois Water Interstation Relationships — Chloride

River mile	Form of equation	Value of a	Value of b	Correlation coefficient
260.4	$y = a + bx$	25.459	0.55217	0.76
250.0	$y = ax^b$	1.13352	0.96134	0.85
239.6	$y = a + bx$	13.915	0.7842	0.74
230.0	$y = a + bx$	11.805	0.69303	0.76
219.0	$y = ax^b$	3.1492	0.70099	0.83
210.0	$y = ax^b$	0.9782	1.0105	0.82
199.8	$y = ax^b$	1.34626	0.91899	0.96
190.0	$y = a + bx$	15.141	0.69833	0.81
179.9	$y = a + bx$	2.741	0.92553	0.83
170.0	$y = ax^b$	1.60391	0.87608	0.86
159.9	$y = a + bx$	13.923	0.73575	0.78
150.2	$y = a + bx$	5.5908	0.93534	0.93
140.1	$y = a + bx$	5.9303	0.87812	0.94
129.9	$y = ax^b$	2.15894	0.79251	0.86
119.9	$y = a + bx$	11.958	0.71907	0.61
110.2	$y = a + bx$	15.35	0.68465	0.76
100.9	$y = ax^b$	1.19769	0.95241	0.93
90.2	$y = ae^{bx}$	20.05	0.01780	0.86
80.2	$y = ae^{bx}$	16.50	0.02160	0.94
70.0	$y = ax^b$	1.07965	0.98016	0.90
60.8	$y = a + bx$	10.877	0.75996	0.82
50.0	$y = ax^b$	1.83164	0.84223	0.87
39.9	$y = a + bx$	-3.1805	1.0500	0.94
30.6	$y = ax^b$	2.31388	0.78000	0.95
20.7	$y = ax^b$	1.062101	0.97644	0.90
10.3	$y = ax^b$	1.10222	0.97924	0.93
3.6	$y = a + bx$	8.2013	0.83206	0.90

Table 4. Illinois Waterway Interstation Relationships - Dissolved Solids

River mile	Form of equation	Value of a	Value of b	Correlation coefficient
260.4	$y = a + bx$	70.573	0.86046	0.86
250.0	$y = a + bx$	-63.088	1.1111	0.83
239.6	$y = a + bx$	179.52	0.6167	0.74
230.0	$y = a + bx$	62.6040	0.79089	0.79
219.0	$y = a + bx$	82.323	0.81093	0.90
210.0	$y = a + bx$	-13.026	1.0288	0.93
199.8	$y = ae^{bx}$	186.60	0.001917	0.93
190.0	$y = ax^b$	2.7992	0.82855	0.67
179.9	$y = a + bx$	169.42	0.58301	0.65
170.0	$y = ax^b$	2.9637	0.82141	0.85
159.9	$y = ae^{bx}$	200.45	0.001792	0.91
150.2	$y = a + bx$	78.830	0.87062	0.87
140.1	$y = a + bx$	85.610	0.79721	0.87
129.9	$y = ax^b$	0.9508	1.0093	0.78
119.9	$y = ax^b$	9.9447	0.62165	0.66
110.2	$y = a + bx$	221.20	0.51411	0.84
100.9	$y = a + bx$	-9.4140	1.0042	0.92
90.2	$y = a + bx$	10.280	0.95129	0.79
80.2	$y = a + bx$	32.863	0.92353	0.77
70.0	$y = a + bx$	160.15	0.60731	0.69
60.8	$y = a + bx$	12.936	0.94522	0.83
50.0	$y = ae^{bx}$	214.79	0.001639	0.59
39.3	$y = ax^b$	0.4704	1.1231	0.95
30.6	$y = ax^b$	55.475	0.33319	0.53
20.7	$y = ax^b$	1.28387	0.95676	0.94
10.3	$y = ae^{bx}$	152.51	0.00241	0.92
3.6	$y = a + bx$	-0.43048	0.98027	0.84

Table 5. Illinois Waterway Interstation Relationship - Alkalinity

River mile	Form of equation	Value of a	Value of b	Correlation coefficient
260.4	$y = ax^b$	4.12411	0.72016	0.71
250.0	$y = ax^b$	5.07984	0.67628	6.73
239.6	$y = ax^b$	0.714546	1.0699	0.88
230.0	$y = ax^b$	22.120758	0.39687	0.59
209.0	$y = a + bx$	17.845	0.91088	0.77
210.0	$y = ax^b$	0.861628	1.0320	0.87
199.8	$y = ax^b$	1.956591	0.86751	0.89
190.0	$y = a + bx$	-1.9286	1.0229	0.99
179.9	$y = a + bx$	2.6974	0.98894	0.97
170.0	$y = ax^b$	0.73804	1.0575	0.91
159.9	$y = ax^b$	11.78691	0.52132	0.64
150.2	$y = ax^b$	5.25594	0.6802	0.74
140.1	$y = a + bx$	0.86358	1.0073	0.98
129.9	$y = ax^b$	0.78105	1.0481	0.99
119.9	$y = ax^b$	2.0630	0.86282	0.95
110.2	$y=ax^b$	2.02960	0.86461	0.95
100.9	$y = a + bx$	11.887	0.92995	0.98
90.2	$y = ax$	0.801431	1.0438	0.98
80.2	$y = ax^b$	1.94554	0.87414	0.97
70.0	$y = ax^b$	0.81602	1.0385	0.97
60.8	$y = a + bx$	6.4024	0.96691	0.97
50.0	$y = ae^{bx}$	68.0418	0.005348	0.97
39.9	$y = ax^b$	1.11372	0.95875	0.82
30.6	$y = ax^b$	2.68522	0.80567	0.84
20.7	$y = a + bx$	11.2940	0.92786	0.96
10.3	$y = a + bx$	-0.54193	1.0323	0.98
3.6	$y = ax^b$	2.05731	0.86169	0.96

Table 6. Illinois Waterway Interstation Relationship — Hardness

River mile	Form of equation	Value of a	Value of b	Correlation coefficient
260.4	$y = a + bx$	101.09	0.61898	0.67
250.0	$y = ae^{bx}$	104.16	0.00362	0.94
239.6	$y = a + bx$	-34.385	1.1266	0.91
230.0	$y = ax^b$	16.6533	0.4980	0.60
219.0	$y = ae^{bx}$	148.12	0.002385	0.67
210.0	$y = ae^{bx}$	122.97	0.002883	0.90
199.8	$y = a + bx$	8.404	0.97586	0.91
190.0	$y = a + bx$	-14.487	1.0674	0.87
179.9	$y = a + bx$	90.533	0.68159	0.76
170.0	$y = a + bx$	99.311	0.63947	0.71
159.9	$y = a + bx$	122.33	0.56767	0.47
150.2	$y = ae^{bx}$	150.21	0.002301	0.69
140.1	$y = a + bx$	57.792	0.82057	0.81
129.9	$y = a + bx$	40.480	0.85245	0.83
119.9	$y = a + bx$	7.3995	0.99009	0.91
110.2	$y = a + bx$	62.263	0.79822	0.79
100.9	$y = a + bx$	71.078	0.77209	0.82
90.2	$y = a + bx$	95.643	0.67029	0.82
80.2	$y = a + bx$	86.031	0.71764	0.83
70.0	$y = a + bx$	4.1698	0.95735	0.79
60.8	$y = ae^{bx}$	226.10	0.000976	0.47
50.0	$y = ae^{bx}$	138.42	0.002486	0.72
39.9	$y = a + bx$	-80.501	1.2476	0.71
30.6	$y = ae^{bx}$	187.070	0.001570	0.71
20.7	$y = ae^{bx}$	154.56	0.002193	0.62
10.3	$y = a + bx$	86.013	0.72919	0.85
3.6	$y = a + bx$	42.966	0.82585	0.80

Table 7. Illinois Waterway Interstation Relationship - Nitrate

River mile	*Form of equation*	*Value of a*	*Value of b*	*Correlation coefficient*
260.4	$y = a + bx$	0.34886	0.9325	0.86
250.0	$y = a + bx$	0.07723	1.0062	0.91
239.6	$y = a + bx$	-0.03303	1.0962	0.95
230.0	$y = a + bx$	0.28651	0.87648	0.91
219.0	$y = a + bx$	0.03308	1.0440	0.99
210.0	$y = a + bx$	-0.01522	1.0185	0.98
199.8	$y = ax^b$	1.00917	0.99200	0.98
190.0	$y = ax^b$	0.89756	1.0726	0.98
179.9	$y = a + bx$	-0.25167	1.03960	0.96
170.0	$y = a + bx$	-0.0428	0.99843	0.98
159.9	$y = a + bx$	-0.35063	1.0472	0.97
150.2	$y = a + bx$	0.19368	0.9511	0.98
140.1	$y = ax^b$	0.98593	1.0272	0.99
129.9	$y = a + bx$	-0.03665	1.0072	0.99
119.9	$y = ax^b$	0.98781	1.0077	0.99
110.2	$y = ax^b$	1.07372	0.93561	0.99
100.9	$y = ax^b$	1.07002	0.94496	0.99
90.2	$y = a + bx$	0.07373	0.98392	0.99
80.2	$y = a + bx$	-0.050781	0.96777	0.98
70.0	$y = ax^b$	1.03760	0.94645	0.99
60.8	$y = a + bx$	0.033331	0.99288	0.99
50.0	$y = ax^b$	1.06025	0.97162	0.99
39.9	$y = ax^b$	1.01826	0.97348	0.99
30.6	$y - ax^b$	0.9743	1.0310	0.99
20.7	$y = ax^b$	1.00239	0.97325	0.99
10.3	$y = ax^b$	1.01630	1.0010	0.99
3.6	$y = ax^b$	1.043367	0.96467	0.99

Table 8. Illinois Waterway Interstation Relationship — Total Phosphorus

River mile	*Form of equation*	*Value of a*	*Value of b*	*Correlation coefficient*
260.4	$y = ae^bx$	0.24	1.4314	0.78
250.0	$y = ax^b$	1.02203	1.1361	0.74
239.6	$y = ax^b$	0.5867	0.2602	0.48
230.0	$y = a + bx$	0.28457	0.34993	0.46
219.0	$y = ax^b$	0.91405	0.8864	0.66
210.0	$y = a + bx$	-0.0031	1.0121	0.72
199.8	$y = a + bx$	0.23775	0.4859	0.60
190.0	$y = a + bx$	0.27007	0.43287	0.46
179.0	$y = ax^b$	0.7000	0.52966	0.53
170.0	$y = ax^b$	0.71515	0.56399	0.63
159.9	$y = ax^b$	0.5809	0.32300	0.40
150.2	$y = ax^b$	0.8149	0.69062	0.58
140.1	$y = ax^b$	0.8992	0.80290	0.56
129.9	$y = ax^b$	0.8564	0.85661	0.61
119.9	$y = ax^b$	0.5893	0.35645	0.62
110.2	$y = ax^b$	0.9174	0.82476	0.60
100.9	$y = ae^{bx}$	0.3570	0.52874	0.18
90.2	$y = ax^b$	0.5355	0.24481	0.32
80.2	$y = a + bx$	0.31328	0.1951	0.30
70.0	$y = ae^x$	0.2180	1.50967	0.62
60.8	$y = ax^b$	0.71062	0.64782	0.54
50.0	$y = ax^b$	0.7351	0.61341	0.72
39.9	$y = a + bx$	-0.02152	1.0781	0.81
30.6	$y = ax^b$	0.7996	0.79855	0.76
20.7	$y = ax^b$	0.7105	0.70291	0.80
10.3	$y = ax^b$	0.5826	0.54419	0.60
3.6	$y = ax^b$	0.3828	0.18254	0.21

Table 9. Observed Averages of Chemical Quality Characteristics in the Illinois Waterway

(Concentrations in mg/l)

River mile	*Chlorides*	*Diss. solids*	*Alkalinity*	*Hardness*	*Nitrate-N*	*Total phospbous*
270.6	58.8	415	168	263	2.52	0.54
260.4	58.0	426	163	264	2.71	0.53
250.0	56.7	413	160	272	2.81	0.50
239.6	58.4	434	163	273	3.04	0.40
230.1	52.2	406	167	272	2.95	0.46
219.8	50.4	412	170	284	3.12	0.46
210.2	51.7	410	173	280	3.16	0.37
199.8	50.5	414	171	281	3.16	0.46
190.0	50.4	415	173	286	3.10	0.47
179.9	49.4	411	174	285	2.97	0.47
170.9	49.0	417	173	282	2.93	0.47
159.9	49.9	426	173	282	2.71	0.46
150.2	51.9	448	176	289	2.83	0.47
140.1	51.5	443	178	295	2.88	0.50
129.9	49.1	447	179	292	2.86	0.49
119.9	47.1	442	179	295	2.93	0.46
110.2	47.7	448	182	299	2.86	0.49
110.9	47.5	441	181	302	2.89	0.48
90.2	47.1	430	182	298	2.91	0.48
80.2	46.0	430	184	300	2.77	0.41
70.0	46.1	421	183	291	2.71	0.41
60.8	45.9	411	184	301	2.73	0.40
50.0	46.0	425	179	293	2.82	0.42
39.3	45.2	422	186	285	2.78	0.43
30.6	45.1	416	181	293	2.81	0.41
20.7	43.9	412	179	295	2.74	0.38
10.3	44.8	414	180	301	2.79	0.35
3.6	45.5	405	180	291	2.80	0.32

A similar scheme was used in estimating the flow values at the time of sample collection along the waterway. Daily average flow values determined at the gaging stations were used in the computations instead of the annual average flow values as discussed above.

Before assessing the diversion impact, it is necessary to estimate the chemical quality characteristics likely to be found in the Illinois Waterway at river mile 270.6 during the average, wet, and dry flow conditions. For this purpose, the flow-concentration relationships for each of the six chemical parameters (chloride, dissolved solids, alkalinity, hardness, nitrate-N, and total phosphorus) were examined by using the set of observed values and the corresponding flow values at river mile 270.6. The three mathematical forms cited earlier were used to examine this relationship. Flow values were treated as independent variables and the corresponding paired values for the chemical parameter were treated as dependent variables. For river mile station 270.6, it was found that there is no statistically significant flow-concentration relationship for any of the six parameters. In other words, the observed concentrations at river mile 270.6 were independent of the flows in the waterway at the time of sample collections. Consequently, the average of observed values was considered as the values likely to be found during the average, wet, and dry flow conditions in the waterway. The observed average values for six parameters at river mile 270.6 and other sampling locations are shown in table 11.

Table 10. Illinois Waterway Mean Annual Discharges, cfs

River mile	Wet year 1973	Dry year 1977	Average year 1971
3.6	**44,888**	**12,925**	**20,512**
10.3	**44,641**	**12,926**	**20,538**
20.7	**44,258**	**12,927**	**20,119**
30.6	**42,738**	**12,615**	**19,623**
39.3	**42,417**	**12,616**	**19,423**
50.0	**42,023**	**12,618**	**19,176**
60.8	**41,625**	**12,619**	**18,928**
70.0	**41,286**	**12,620**	**18,716**
80.2	**40,910**	**12,621**	**18,481**
90.2	**38,929**	**12,333**	**17,589**
100.9	**30,743**	**10,083**	**15,045**
110.2	**30,400**	**10,084**	**14,831**
119.9	**30,043**	**10,085**	**14,608**
129.9	**27,241**	**9,357**	**13,397**
140.1	26,865	9,358	13,162
150.2	24,823	8,870	12,414
159.9	24,523	8,776	12,271
170.9	24,183	8,669	12,108
179.9	23,905	8,582	11,975
190.0	23,593	8,485	11,825
199.8	23,291	8,390	11,680
210.2	22,224	9,253	11,262
219.8	22,716	8,160	11,120
230.1	19,433	7,763	10,317
239.6	19,139	7,671	10,177
250.0	14,990	6,873	8,281
260.4	14,669	6,773	8,127
270.6	13,549	6,484	7,726

Water quality characteristics of the Lake Michigan water were obtained from *Lake Michigan Water Quality Reports* (Illinois Environmental Protection Agency, 1974, 1975, 1976, and 1977) and from the Illinois State Water Survey's data file (Ackermann et al., 1970). With knowledge of the quality characteristics of the Illinois River at river mile 270.6 under various flow conditions, and the Lake Michigan waters, the resulting concentrations of the chemical constituents under consideration were computed by volumetric flow mixing equations. Lake Michigan characteristics, initial river water characteristics, and the computed chemical characteristics at river mile 270.6 for two different lake diversion schemes, 3400 and 6800 cfs, are shown in tables 11 and 12.

With the initial conditions of water quality characteristics summarized in tables 11 and 12 and , with the set of interstation relationship equations developed for each of the chemical constituents shown in tables 3 through 8, the chemical quality of the waterway as it progressed downstream was predicted. The predicted values, under three different waterway flow conditions and two different diversion schemes, are shown in tables 13 through 18. The results pertaining to 3400 cfs Lake Michigan diversion are plotted in figure 2 for chloride, dis-

Table 11. Initial Conditions at River Mile 270.6 of the Illinois Waterway — 3400 cfs Diversion

(Concentrations in mg/l)

Parameters	Lake Michigan	Dry-year flow		Average flow		Wet-year flow	
		River	After dilution	River	After dilution	River	After dilution
Chloride	9	58.8	41.7	58.8	43.6	58.8	48.8
Diss. solids	165	415	329	415	339	415	365
Alkalinity	118	168	151	168	153	168	158
Hardness	130	263	217	263	222	263	236
Nitrate-N	1.20	2.52	2.07	2.52	2.12	2.52	2.26
Total phosphorus	0.05	0.54	0.37	0.54	0.39	0.54	0.44

Table 12. Initial Conditions at River Mile 270.6 of the Illinois Waterway — 6800 cfs Diversion

(Concentrations in mg/l)

Parameters	Lake Michigan	Dry-year flow		Average flow		Wet-year flow	
		River	After diversion	River	After diversion	River	After diversion
Chloride	9	58.8	33.3	58.8	35.5	58.8	42.2
Diss. solids	165	415	287	415	298	415	331
Alkalinity	118	168	142	168	145	168	151
Hardness	130	263	195	263	201	263	219
Nitrate-N	1.20	2.52	1.84	2.52	1.90	2.52	2.08
Total phosphorus	0.05	0.54	0.29	0.54	0.31	0.54	0.38

Table 13. Effects of Lake Michigan Diversion on the Water Chemistry of the Illinois Waterway — Dry-year Flow Conditions, 3400 cfs Diversion

River mile	*Chloride*	*Diss. solids*	*Alkalinity*	*Hardness*	*Nitrate-N*	*Total phosphorus*
270.6	41.7	329	151	217	2.07	0.37
260.4	48.4	354	153	235	2.28	0.41
250.0	47.2	330	153	244	2.37	0.37
239.6	50.9	383	155	241	2.50	0.45
230.1	47.1	366	164	256	2.53	0.44
219.8	46.9	379	167	273	2.67	0.44
210.2	47.8	377	169	270	2.70	0.44
199.8	47.0	384	168	272	2.70	0.45
190.0	48.0	388	170	276	2.60	0.46
179.9	47.2	395	171	279	2.45	0.46
170.9	47.0	403	170	278	2.40	0.46
159.9	48.5	413	171	280	2.16	0.45
150.2	51.0	438	174	286	2.25	0.47
140.1	50.7	435	176	292	2.27	0.49
129.9	48.5	437	176	289	2.25	0.46
119.9	46.8	435	179	294	2.24	0.45
110.2	47.4	445	180	297	2.28	0.47
100.9	47.3	438	179	300	2.33	0.46
90.2	46.5	427	180	297	2.37	0.44
80.2	45.1	427	182	299	2.24	0.40
70.0	45.1	419	181	290	2.23	0.40
60.8	45.2	409	181	300	2.25	0.39
50.0	45.3	419	179	292	2.33	0.41
39.3	44.4	414	161	284	2.32	0.42
30.6	44.6	413	161	292	2.32	0.40
20.7	43.3	409	161	293	2.27	0.37
10.3	44.1	409	164	300	2.31	0.34
3.6	44.9	400	167	291	2.34	0.31

Table 14. Effects of Lake Michigan Diversion on the Water Chemistry of the Illinois Waterway — Average Flow Conditions, 3400 cfs Diversion

River mile	*Chloride*	*Diss. solids*	*Alkalinity*	*Hardness*	*Nitrate-N*	*Total phosphorus*
270.6	43.6	339	153	222	2.12	0.39
260.4	49.5	362	154	239	2.3	0.42
250.0	48.3	339	153	247	2.42	0.38
239.6	51.8	389	156	244	2.62	0.46
230.1	47.7	370	164	257	2.58	0.44
219.8	47.3	382	167	274	2.72	0.45
210.2	48.2	380	170	271	2.75	0.45
199.8	47.4	387	168	272	2.75	0.46
190.0	48.2	390	170	276	2.66	0.47
179.9	47.4	397	171	279	2.51	0.47
170.9	47.1	404	170	278	2.47	0.47
159.9	48.6	413	171	280	2.23	0.45
150.2	51.0	430	174	286	2.32	0.47
140.1	50.7	435	176	293	2.34	0.49
129.9	48.5	438	176	290	2.32	0.46
119.9	46.8	436	179	294	2.30	0.45
110.2	47.4	445	180	297	2.34	0.47
100.9	47.3	438	179	301	2.39	0.46
90.2	46.5	427	180	297	2.43	0.44
80.2	45.1	427	182	299	2.30	0.40
70.0	45.1	420	182	291	2.28	0.40
60.8	45.2	409	182	300	2.30	0.39
50.0	45.3	419	180	292	2.38	0.41
39.3	44.4	414	162	284	2.37	0.42
30.6	44.6	413	162	292	2.37	0.40
20.7	43.3	409	162	298	2.37	0.37
10.3	44.1	409	167	300	2.41	0.34
3.6	44.9	400	167	291	2.49	0.31

Table 15. Effects of Lake Michigan Diversion on the Water Chemistry of the Illinois Waterway — Wet-Year Flow Conditions, 3400 cfs Diversion

River mile	*Chloride*	*Diss. solids*	*Alkalinity*	*Hardness*	*Nitrate-N*	*Total phosphorus*
270.6	48.8	365	158	236	2.26	0.44
260.4	52.4	385	158	241	2.46	0.45
250.0	51.0	364	156	255	2.55	0.41
239.6	53.9	404	159	253	2.76	0.47
230.1	49.2	382	165	262	2.71	0.45
219.8	48.3	392	168	277	2.86	0.45
210.2	49.2	391	171	273	2.90	0.45
199.8	48.3	395	169	275	2.90	0.46
190.0	48.9	396	171	279	2.81	0.47
179.9	48.0	400	172	281	2.67	0.47
170.9	47.6	407	171	279	2.62	0.47
159.9	49.0	416	172	281	2.39	0.45
150.2	51.4	441	174	286	2.47	0.47
140.1	51.1	437	176	293	2.50	0.49
129.9	48.7	440	177	290	2.48	0.47
119.9	47.0	437	179	295	2.46	0.45
110.2	47.5	446	180	297	2.50	0.47
100.9	47.4	438	179	301	2.54	0.46
90.2	46.6	428	181	297	2.57	0.44
80.2	45.1	428	183	299	2.44	0.40
70.0	45.2	420	182	291	2.41	0.40
60.8	45.2	410	183	300	2.43	0.39
50.0	45.4	419	181	292	2.51	0.41
39.3	44.5	414	162	284	2.49	0.42
30.6	44.7	413	162	292	2.50	0.40
20.7	43.4	409	162	293	2.44	0.37
10.3	44.2	409	166	300	2.48	0.34
3.6	45.0	400	169	291	2.51	0.31

Table 16. Effects of Lake Michigan Diversion on the Water Chemistry of the Illinois Waterway — Dry-Year Flow Conditions, 6800 cfs Diversion

River mile	*Chloride*	*Diss. solids*	*Alkalinity*	*Hardness*	*Nitrate-N*	*Total phosphorus*
270.6	33.3	288	142	195	1.84	0.29
260.4	43.8	318	146	222	2.06	0.36
250.0	42.9	291	148	232	2.15	0.32
239.6	47.6	359	150	228	2.33	0.44
230.1	44.8	346	163	248	2.32	0.44
219.8	45.3	363	166	268	2.46	0.44
210.2	46.1	361	169	266	2.49	0.44
199.8	45.5	373	167	268	2.50	0.45
190.0	46.9	378	169	272	2.40	0.47
179.9	46.1	390	170	276	2.24	0.47
170.9	46.0	398	169	276	2.28	0.47
159.9	47.8	409	171	279	2.04	0.45
150.2	50.3	435	174	285	2.13	0.47
140.1	50.1	432	176	292	2.15	0.49
129.9	48.0	435	176	289	2.13	0.46
110.9	46.5	434	179	294	2.11	0.45
110.2	47.2	444	180	297	2.16	0.47
100.9	47.0	437	179	300	2.21	0.46
90.2	46.3	426	180	297	2.25	0.44
80.2	44.9	426	182	299	2.23	0.40
70.0	44.9	419	182	291	2.22	0.40
60.8	45.0	409	182	300	2.23	0.39
50.0	45.2	419	180	292	2.32	0.41
39.3	44.3	414	162	284	2.31	0.46
30.6	44.5	413	162	281	2.31	0.43
20.7	43.2	409	161	286	2.26	0.39
10.3	44.1	408	166	295	2.30	0.35
3.6	44.9	400	168	286	2.33	0.32

Table 17. Effects of Lake Michigan Diversion on the Water Chemistry of the Illinois Waterway — Average Flow Conditions, 6800 cfs Diversion

River mile	*Chloride*	*Diss. solids*	*Alkalinity*	*Hardness*	*Nitrate-N*	*Total phosphorus*
270.6	35.5	209	145	201	1.90	0.31
260.4	45.1	327	149	226	2.12	0.37
250.0	44.1	300	149	236	2.21	0.33
239.6	48.5	365	152	231	2.46	0.44
230.1	45.4	351	162	250	2.44	0.44
219.8	45.7	367	166	269	2.58	0.44
210.2	46.5	364	168	267	2.64	0.44
199.8	45.9	375	167	269	2.65	0.45
190.0	47.7	380	169	273	2.55	0.47
179.4	46.4	391	170	276	2.40	0.47
170.9	46.3	399	168	276	2.35	0.47
159.9	48.0	410	171	279	2.11	0.45
150.2	50.5	436	173	285	2.20	0.47
140.1	50.2	433	174	292	2.22	0.49
129.9	48.1	435	175	289	2.27	0.46
119.9	46.6	435	178	294	2.26	0.45
110.2	47.2	445	179	297	2.30	0.47
100.9	47.1	437	179	300	2.35	0.46
90.2	46.3	426	180	297	2.39	0.44
80.2	44.9	426	182	299	2.26	0.40
70.0	44.9	419	181	291	2.25	0.40
60.8	45.0	409	182	300	2.26	0.39
50.0	45.2	419	180	292	2.34	0.41
39.3	44.3	414	162	284	2.33	0.42
30.6	44.5	413	162	292	2.33	0.40
20.7	43.2	409	161	293	2.29	0.40
10.3	44.1	408	166	300	2.33	0.35
3.6	44.9	400	169	291	2.36	0.28

Table 18. Effects of Lake Michigan Diversion on the Water Chemistry of the Illinois Waterway — Wet-Year Flow Conditions, 6800 cfs Diversion

River mile	*Chloride*	*Diss. solids*	*Alkalinity*	*Hardness*	*Nitrate-N*	*Total phosphorus*
270.6	42.2	331	151	219	2.08	0.38
260.4	48.8	355	153	237	2.29	0.41
250.0	47.6	332	152	245	2.38	0.37
239.6	51.2	384	155	242	2.58	0.45
230.1	47.3	366	164	256	2.54	0.44
219.8	47.0	379	167	273	2.69	0.44
210.2	47.9	377	169	270	2.72	0.45
199.8	47.1	385	168	272	2.73	0.45
190.0	48.0	388	170	276	2.63	0.47
179.9	47.2	396	171	279	2.48	0.47
170.9	47.0	403	169	277	2.44	0.47
159.9	48.5	413	171	280	2.20	0.45
150.2	50.9	438	174	286	2.29	0.47
140.1	50.7	435	176	292	2.31	0.49
129.9	48.4	438	176	290	2.36	0.47
119.9	46.8	436	179	294	2.35	0.45
110.2	47.4	445	180	297	2.39	0.47
100.9	47.2	438	179	301	2.44	0.46
90.2	46.5	427	180	297	2.47	0.44
80.2	45.0	427	182	299	2.34	0.40
70.0	45.1	420	182	291	2.31	0.40
60.8	45.1	410	182	300	2.34	0.39
50.0	45.3	419	180	292	2.42	0.41
39.3	44.4	415	162	284	2.41	0.42
30.6	44.6	413	162	292	2.41	0.40
20.7	43.3	409	161	293	2.36	0.38
10.3	44.2	409	166	300	2.40	0.34
3.6	44.9	400	169	300	2.43	0.31

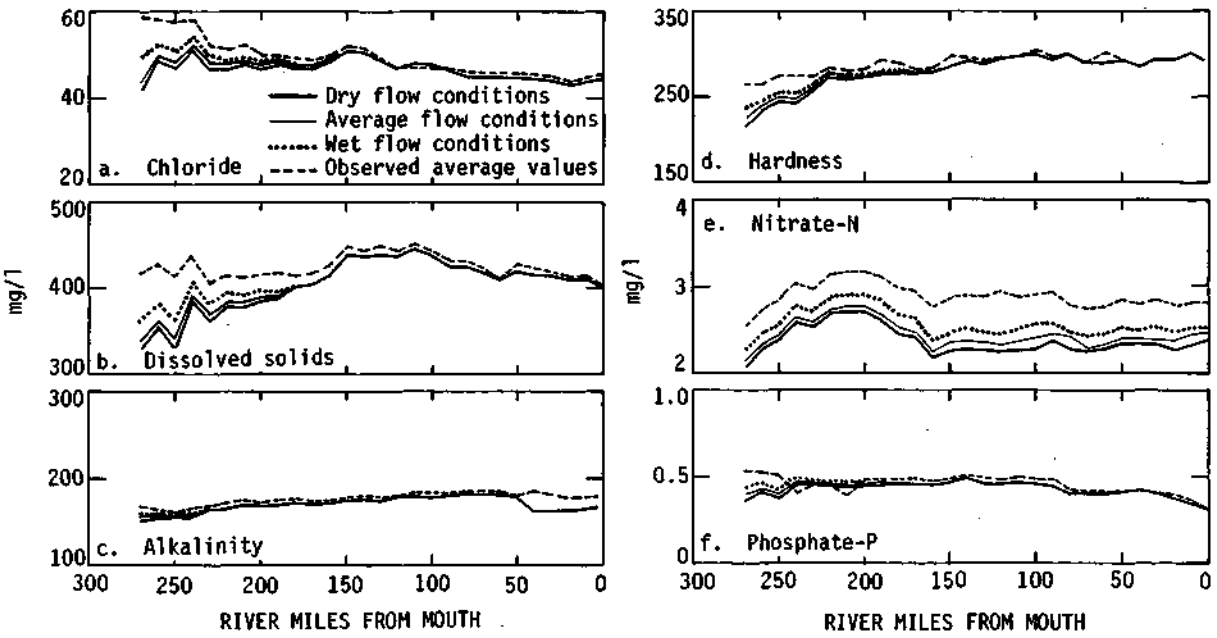

Figure 2. Predicted chemical quality characteristics in Illinois Waterway at 3400 cfs diversion (statistical evaluation)

solved solids, hardness, nitrate-N, and total phosphorus. Figure 3 depicts the impact of an increased diversion of 6800 cfs. The means of observed values of these chemical parameters are also included.

The initial dilution effects of the high quality Lake Michigan waters are apparent from figures 2 and 3. Predictably, the initial effects of diversion are greater during the low waterway flows and the highest diversion flows. At river mile 270.6 the reductions in constituent concentrations are:

Constituent	*Percent reduction*
Chloride	43
Dissolved solids	31
Alkalinity	16
Hardness	26
Nitrate-N	27
Total phosphorus	46

The differences between the mean observed values (without diversion) and the values resulting from diversion flows are attenuated at about 80 to 120 miles downstream in the case of 3400 cfs diversion. The influence of diversion on the water chemistry of the waterway, mostly beneficial, will linger farther downstream in the case of the 6800 cfs diversion. Only in the case of nitrate-N do the impacts of both schemes of diversion appear to persist throughout the waterway during all of the three flow conditions investigated. This is probably indicative of the uniformity of the influence of geochemistry and anthropogenic effects within the watershed.

The general dampening influence of diversion is due to the increasing waterway flows with downstream movement thus lessening the effect of dilution. These estimates are based on the assumption that the lake water will be delivered directly to the Des Plaines River. However, in reality it will be delivered through the canal system of the Metropolitan Sanitary District of Greater Chicago and hence to the Des Plaines River. Consequently, the differences depicted in figures 2 and 3 between observed and predicted values will be further reduced. The mineral content of the mixed flow will not be so drastically altered as to affect the osmotic balance of the waterway's fauna and flora.

On the basis of this method of analysis, the diversion of Lake Michigan waters will improve the chemical quality of the waterway by measurably lessening the concentration of chlorides, dissolved solids, and hardness approximately 120 miles downstream of Dresden Island Lock and Dam. Nitrate concentrations will be reduced throughout this part of the waterway, but the reduction in alkalinity and phosphorus will not be significant.

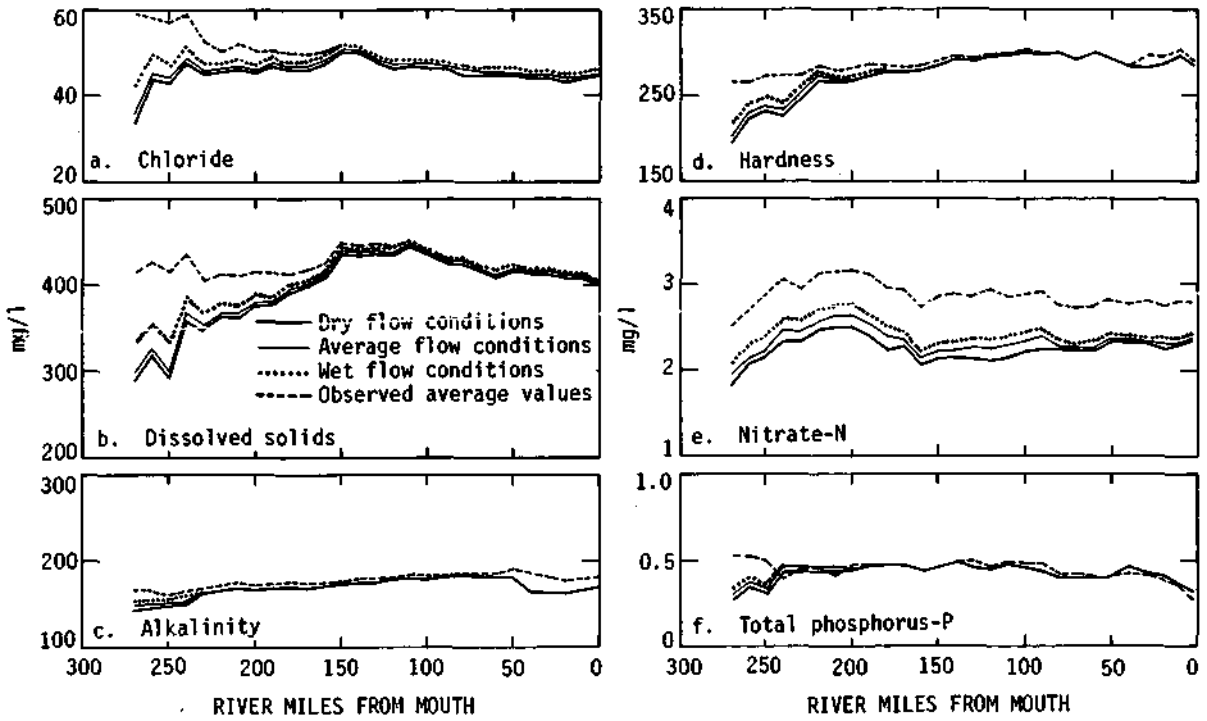

Figure 3. Predicted chemical quality characteristics in Illinois Waterway at 6800 cfs diversion (statistical evaluation)

Mass Balance Analysis

Before the start of field sampling in 1979, it was decided that a mass balance analysis approach should also be used in evaluating the impact of the increased Lake Michigan diversions. With this intent, field observations and sample collections were made for nine major tributaries of the waterway. This was performed along with the data gathering effort on the main stem of the waterway in a manner similar to the first-year effort.

As mentioned earlier, these tributary sampling sites are reasonably close to the points of confluence of the tributaries and the Illinois Waterway. Figure 4 shows schematically the Illinois Waterway, its major tributaries, and the division of the waterway into river reaches for mass balance analysis. The main stem was divided into nine reaches with each reach containing a tributary. The upper and lower boundaries of each reach and the point of confluence of a tributary with the river are demarcated with river mile designations. For example, the uppermost reach in the waterway is bounded by river miles 270.6 and 250.0 and contains the tributary Mazon River joining the Illinois River at 263.0.

In carrying out the mass balance analysis, the principle of conservation of matter is implied. This is probably true only in the case of chloride, among the six chemical parameters dealt with in this investigation. Nevertheless, the analysis is extended to the other five parameters for the purposes of deriving some estimates and comparing them with the results obtained by the statistical method described earlier.

The elements of mass balance analysis are shown in figure 5. The mass balance equation used in the analysis is:

$$C_d = (Q_u \times C_u + Q_t \times C_t \pm Q_b \times C_b)/Q_d \qquad (4)$$

where

C_d = predicted value in mg/1 at the downstream boundary of the river reach
Q_d = flow in cfs at the downstream boundary
Q_u = flow in cfs at the upstream boundary of the river reach
C_u = concentration in mg/l at the upstream boundary
Q_t = flow in cfs of the tributary

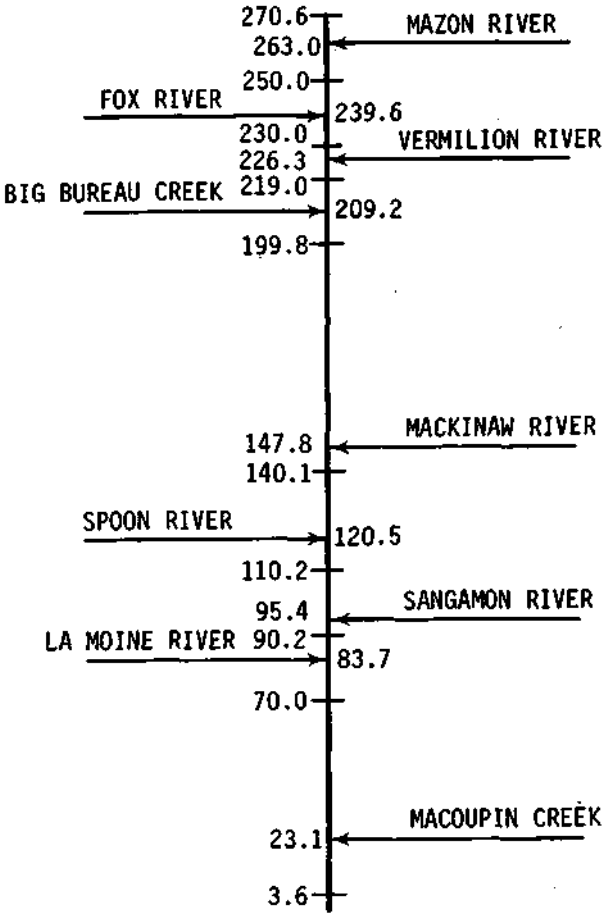

Figure 4. Schematic diagram of the Illinois waterway and its tributaries

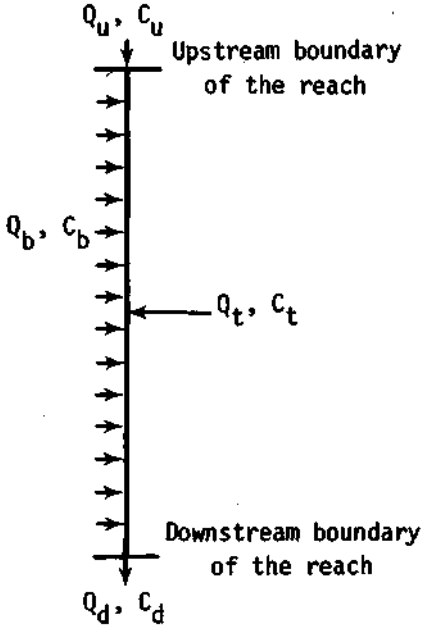

Figure 5. Elements of mass balance analysis

C_t = concentration of the chemical parameter in the tributary

Q_b = baseflow or groundwater inflow in cfs given by the expression (Q_d — Q_u)

C_b = concentration of the chemical parameter under consideration in the groundwater inflow

The chemical characteristics of the groundwater inflow were estimated from the State Water Survey's publication *Groundwater Conditions and River-Aquifer Relationships along the Illinois Waterway* (Gibb et al., 1979). Values for the groundwater quality characteristics of well water samples within a given river reach were averaged and used for defining the impact of baseflow in the mass balance analysis. Values used for all the reaches in the waterway are shown in table 19. Since there was no reported value for groundwater total phosphorus concentration available for the entire waterway, a uniform value of 0.05 mg/1 was assumed.

The chemical quality characteristics of the tributaries for the flow conditions observed during 1971, 1973, and 1977 were estimated from the flow-concentration relationship developed from the data observed in 1979. If the flow-concentration relationship for a parameter was not found statistically significant, the mean of the observed values was used for that parameter. The procedure was essentially similar to the one used for determining the initial conditions at river mile 270.6

Estimated values for the chemical parameters under three different flow conditions are shown in table 20 for the nine tributaries. The observed annual average flows at the gaging stations of the tributaries for the years 1971, 1973, and 1977 were increased in proportion to the watershed areas of the tributaries at their confluence points with the Illinois River and the watershed areas at the gaging stations.

Starting with the waterway reach of river miles 270.6 to 250, and knowing the initial conditions of the chemical quality characteristics of the waterway at mile point 270.6 (as shown in table 11), we can estimate the expected concentrations at the downstream boundary of the reach with equation 4. The downstream values computed then form the initial conditions for the next reach. The effects of the increased lake diversion are propagated until the end of the waterway is reached. The results of mass

Table 19. Estimated Baseflow Characteristics of Different Waterway Reaches

(Concentrations, mg/l)

Reach	*Chloride*	*Diss. solids*	*Alkalinity*	*Hardness*	*Nitrate-N*	*Total phosphorus*
270.6-250.0	53	859	440	639	0.9	0.05
250.0-230.0	53	859	440	639	0.9	0.05
230.0-219.0	53	859	440	639	0.9	0.05
219.0-199.8	40	628	260	448	7.2	0.05
199.8-140.1	40	564	338	359	16.9	0.05
140.1-110.2	40	574	3221	436	25.9	0.05
110.2- 90.2	65	289	157	194	5.9	0.05
90.2- 70.0	38	119	244	318	8.8	0.05
70.0- 3.6	45	517	351	414	5.1	0.05

Table 20. Chemical Quality Characteristics of the Tributaries at Different Flow Conditions

(Concentrations — mg/l. Flows — cfs)

Parameter	*Dry*	*Average*	*Wet*
Mazon River at the confluence			
Estimated flow	165	217	699
Chloride	29.8	29.8	29.8
Dissolved solids	546	546	546
Alkalinity	205	207	213
Hardness	390	390	390
Nitrate	7.6	8.55	14.13
Total phosphorus	0.10	0.11	0.13
Fox River at the confluence			
Estimated flow	693	1732	3805
Chloride	47.2	39.1	33.1
Dissolved solids	415	415	415
Alkalinity	207	207	207
Hardness	300	300	300
Nitrate	0.45	1.63	4.00
Total phosphorus	0.30	0.30	0.30
Vermilion River at the confluence			
Flow	280	611	2045
Chloride	26.3	26.3	26.3
Dissolved solids	460	460	460
Alkalinity	197	197	197
Hardness	339	337	334
Nitrate	1.36	1.36	1.36
Total phosphorus	0.26	0.26	0.26
Big Bureau River at the confluence			
Flow	14.6	107	301
Chloride	15.5	17.0	20.1
Dissolved solids	469	469	469
Alkalinity	272	265	251
Hardness	337	337	337
Nitrate	2.07	3.58	6.75
Total phosphorus	0.16	0.20	0.33
Mackinaw River at the confluence			
Flow	299	375	1147
Chloride	19.6	20.6	31.2
Dissolved solids	430	444	519
Alkalinity	227	227	227
Hardness	276	276	276
Nitrate	6.97	8.12	17.26
Total phosphorus	0.19	0.19	0.19
Spoon River at the confluence			
Flow	643	865	2146
Chloride	20.3	20.5	21.2
Dissolved solids	431	405	283
Alkalinity	203	193	145
Hardness	323	305	219
Nitrate	4.11	6.41	25.06
Total phosphorus	0.61	0.91	8.61
Sangamon River at the confluence			
Flow	2117	2160	7325
Chloride	33	33	33
Dissolved solids	381	381	381
Alkalinity	214	214	214
Hardness	389	289	289
Nitrate	2.54	2.54	2.54
Total phosphorus	0.47	0.47	0.47
LaMoine River at the confluence			
Flow	277	634	1544
Chloride	16.0	16.0	16.0
Dissolved solids	296	296	296
Alkalinity	188	188	188
Hardness	254	254	254
Nitrate	2.11	2.11	2.11
Total phosphorus	0.31	0.31	0.31
Macoupin River at the confluence			
Flow	242	283	1043
Chloride	9.2	9.2	9.2
Dissolved solids	367	367	367
Alkalinity	248	248	248
Hardness	297	297	297
Nitrate	0.36	0.36	0.36
Total phosphorus	0.27	0.27	0.27

Table 21. Impact of Lake Michigan Diversion on Illinois River Chemical Constituents druring Dry Flow Conditions — 3400 cfs Diversion

(Mass balance analysis; concentrations in mg/l; flo ws in cfs)

Reach	Q_u	C_u	Q_t	C_t	Q_d	C_b	*Pred* Q_d
a. Chlorides							
270.6-250.0	9880	41.7	165	29.8	10270	53.0	41.8
250.0-230.0	10270	41.8	693	47.2	11160	53.0	42.3
230.1-219.0	11160	42.3	280	26.3	11560	53.0	42.0
219.0-199.8	11560	42.0	15	15.5	11790	38.0	41.9
199.8-140.1	11790	41.9	299	19.6	12960	37.0	41.1
140.1-110.2	12960	41.1	643	20.3	13480	49.0	40.0
110.2- 90.2	13480	40.0	2117	33.0	15730	39.0	39.0
90.2- 70.0	15730	39.0	277	16.0	16020	28.0	38.6
70.0- 3.6	16020	38.6	242	9.2	16330	35.0	38.1
b. Dissolved solids							
270.6-250.0	9880	329	165	546	10270	859	344
250.0-230.0	10270	344	693	415	11160	859	357
230.0-219.0	11160	357	280	460	11560	859	365
219.0-199.8	11560	365	15	469	11790	628	370
199.8-140.1	11790	370	299	430	12960	564	384
140.1-110.2	12960	384	643	431	13480	574	385
110.2- 90.2	13480	385	2117	381	15730	289	384
90.2- 70.0	15730	384	277	296	16020	119	382
70.0- 3.6	16020	382	242	367	16330	517	382
c. Alkalinity							
270.6-250.0	9880	151	165	205	10270	440	158
250.0-230.0	10270	158	693	207	11160	440	166
230.0-219.0	11160	166	280	197	11560	440	170
219.0-199.8	11560	170	15	272	11790	260	172
199.8-140.1	11790	172	299	227	12960	338	184
140.1-110.2	12960	184	643	203	13480	322	184
110.2- 90.2	13480	184	2117	214	15730	157	188
90.2- 70.0	15730	188	277	188	16020	244	188
70.0- 3.6	16020	188	242	248	16330	351	190
d. Hardness							
270-6-250.0	9880	217	165	390	10270	639	229
250.0-230.0	10270	229	693	300	11160	639	241
230.0-219.0	11160	241	280	339	11560	639	248
219.0-199.8	11560	248	15	337	11790	448	252
199.8-140.1	11790	252	299	276	12960	359	260
140.1-110.2	12960	260	643	323	13480	436	261
110.2- 90.2	13480	261	2117	289	15730	194	264
90.2- 70.0	15730	264	277	254	16020	318	264
70.0- 3.6	16020	264	242	297	16330	414	265

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Table 21. Concluded

Reach	Q_u	C_t	Q_t	C_t	Q_d	C_b	Pred C_d
e. Nitrate							
270.6-250.0	9880	2.07	165	7.60	10270	0.9	2.13
250.0-230.0	10270	2.13	695	0.65	11160	0.9	2.00
230.0-219.0	11160	2.00	280	1.36	11560	0.9	1.97
219.0-199.8	11560	1.97	15	2.07	11790	7.2	2.07
199.8-140.1	11790	2.07	299	6.97	12960	16.9	3.18
140.1-110.2	12960	3.18	643	4.11	13480	25.9	3.02
110.2- 90.2	13480	3.02	2117	2.54	15730	5.9	2.98
90.2- 70.0	15730	2.98	277	2.11	16020	8.8	2.97
70.0- 3.6	16020	2.97	242	0.36	16330	5.1	2.94
f. Total phosphorus							
270.6-250.0	9880	0.37	165	0.10	10270	0.05	0.36
250.0-230.0	10270	0.36	693	0.30	11160	0.05	0.35
230.0-219.0	11160	0.35	280	0.26	11560	0.05	0.34
219.0-199.8	11560	0.34	15	0.16	11790	0.05	0.33
199.8-140.1	11790	0.33	299	0.19	12960	0.05	0.31
140.1-110.2	12960	0.31	643	0.61	13480	0.05	0.33
110.2- 90.2	13480	0.33	2117	0.47	15730	0.05	0.35
90.2- 70.0	15730	0.35	277	0.31	16020	0.05	0.35
70.0- 3.6	16020	0.35	242	0.27	16330	0.05	0.35

balance analysis for the dry-year flow conditions in the waterway with an increased diversion of 3400 cfs are shown in table 21. Results pertaining to other flow conditions and diversion rates are included in the appendix. However, all the results are shown in figures 6 and 7.

The striking difference between the two methods of evaluation of the impact of lake diversion is that the predicted values for all the chemical parameters are distinctly different under all the flow and diversion conditions throughout the waterway in the case of the mass balance analysis method. In the statistical analysis, the values start out distinctly different because of the dilution effect of the lake waters and then tend to converge to a more or less common value within about 120 miles. The trend in the predicted values follows the means of the observed values of the chemical constituents. The statistical approach is essentially a black box approach for examining the physical, chemical, and biological interactions within the aquatic environment without individually examining these effects. The statistical models used in the predictions were based on actual observed data. Essentially all the components in the mass balance data are estimated or extrapolated from observed data. However, the values predicted by the two methods are similar in magnitude except in the case of nitrate. The predicted nitrate concentrations under wet-year flow conditions are muchhigherbecauseof high estimated nitrate-N concentrations in the Mackinaw and Spoon Rivers under wet flow conditions (table 20).

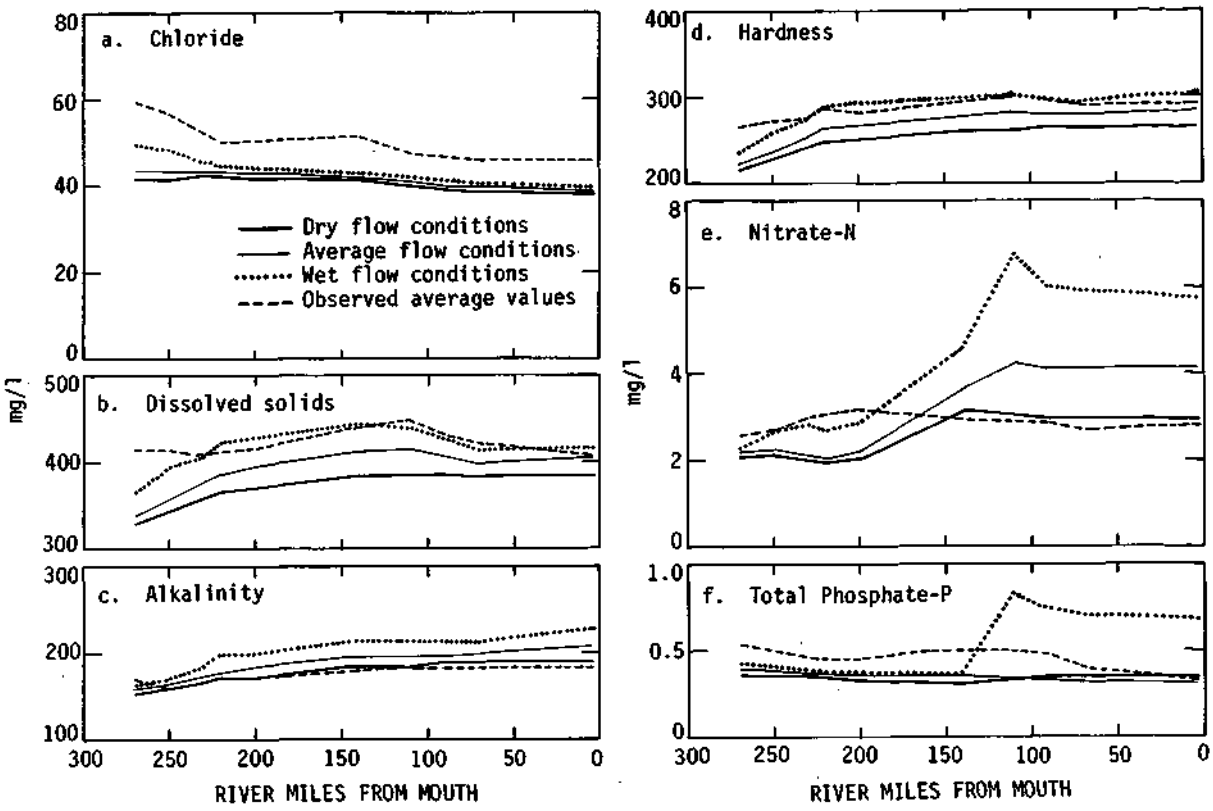

Figure 6. Predicted chemical quality characteristics in Illinois Waterway at 3400 cfs diversion (mass balance analysis)

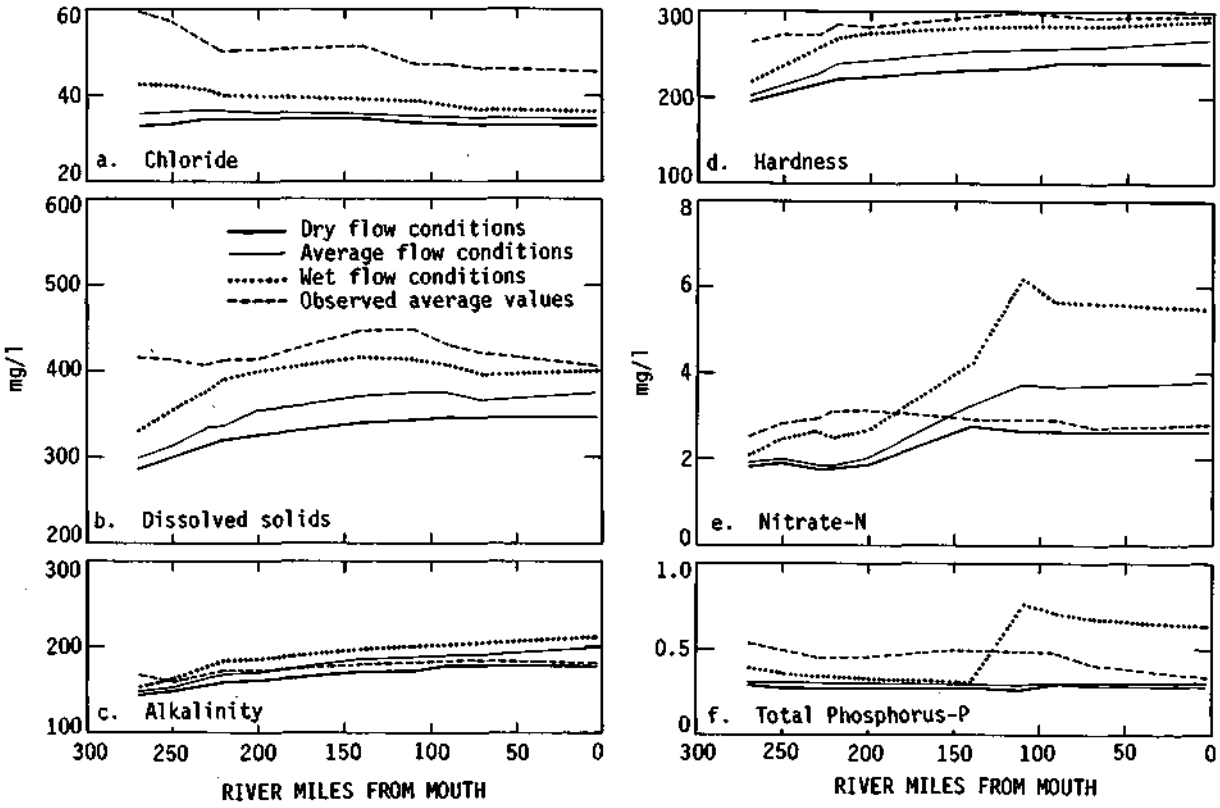

Figure 7. Predicted chemical quality characteristics in Illinois Waterway at 6800 cfs diversion (mass balance analysis)

SUMMARY

A two-year field sampling effort was undertaken by the Water Quality Section of the State Water Survey to collect prediversion water chemistry data along the Illinois Waterway. Twenty-eight sampling locations were established at approximately 10-mile intervals covering a stretch of 270 miles of the waterway. During the first year of sampling in 1978, only the main stem was monitored, and observations and sample collections were made for determining temperature, dissolved oxygen, turbidity, pH, alkalinity, hardness, chlorides, total solids, suspended solids, orthophosphorus, total phosphorous, ammonia nitrogen, and nitrate-nitrogen. During the following year, tributaries to the Illinois River were monitored in addition to the waterway. In all, 16 physical and chemical data sets were developed.

The observed data for the waterway were used in evaluating the magnitude of the impacts of the increased Lake Michigan diversion on the water chemistry of the waterway. Two schemes of diversion, namely, increased diversions of 3400 and 6800 cfs, under each of the three different flow conditions in the waterway were examined. The annual average flow values measured in the waterway during 1971, 1973, and 1977 were taken to represent the average, wet, and dry flow conditions, respectively.

Two different methods were employed in evaluating the data. A statistical method was used to develop a set of mathematical equations to define the interstation relationships for the chemical parameters chloride, dissolved solids, alkalinity, hardness, nitrate-N, and total phosphorus. These mathematical models were used to predict the effects of Lake Michigan diversion. Also, a mass balance analysis, with an implied conservation of matter, was carried out. The results obtained from these two analyses were in reasonable agreement.

The diversion of Lake Michigan waters will improve the chemical quality of the waterway. The mineral content of the mixed flow resulting from increased diversions under the average, wet, and dry flow conditions in the waterway are not likely to be altered drastically enough to affect the osmotic balance of the waterway's fauna and flora.

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Appendix A-1. Impact of Lake Michigan Diversion on Illinois River Chemical Constituents during Dry-Year Flow Conditions — 6800 cfs Diversion

(Mass balance analysis; concentrations in mg/l; flows in cfs)

a. Chlorides

Reach	Q_u	C_u	Q_t	C_t	Q_d	C_b	Pred C_d
270.6 - 250.0	13280	33.3	165	29.8	13670	53.0	33.6
250.0 - 230.0	13670	33.6	693	47.2	14560	53.0	34.5
230.0 - 219.0	14560	34.5	280	26.3	14960	53.0	34.5
219.0 - 199.8	14960	34.5	15	15.5	15190	38.0	34.5
199.8 - 140.1	15190	34.5	299	19.6	16360	37.0	34.4
140.1 - 110.2	16360	34.4	643	20.3	16880	49.0	33.7
110.2 - 90.2	16880	33.7	2117	33.3	19130	39.0	33.6
90.2 - 70.0	19130	33.6	277	16.0	19420	28.0	33.3
70.0 - 3.6	19420	33.3	242	9.2	19730	35.0	33.0

b. Dissolved solids

Reach	Q_u	C_u	Q_t	C_t	Q_d	C_b	Pred C_d
270.6 - 250.0	13280	287	165	546	13670	859	300
250.0 - 230.0	13670	300	693	415	14560	859	313
230.0 - 219.0	14560	313	280	460	14960	859	320
219.0 - 199.8	14960	320	15	469	15190	628	325
199.8 - 140.1	15190	325	299	430	16360	564	340
140.1 - 110.2	16360	340	643	431	16880	574	342
110.2 - 90.2	16880	342	2117	381	19130	289	346
90.2 - 70.0	19130	346	277	296	19420	119	345
70.0 - 3.6	19420	345	242	367	19730	517	346

c. Alkalinity

Reach	Q_u	C_u	Q_t	C_t	Q_d	C_b	Pred C_d
270.6 - 250.0	13280	142	165	205	13670	440	148
250.0 - 230.0	13670	148	693	207	14560	440	155
230.0 - 219.0	14560	155	280	197	14960	440	158
219.0 - 199.8	14960	158	15	272	15190	260	160
199.8 - 140.1	15190	160	299	227	16360	338	171
140.1-110.2	16360	171	643	203	16880	322	171
110.2 - 90.2	16880	171	2117	214	19130	157	176
90.2 - 70.0	19130	176	277	188	19420	244	176
70.0 - 3.6	19420	176	242	248	19730	351	177

Appendix A-1 (Concluded)

d. Hardness

Reach	Q_u	C_u	Q_t	C_t	Q_d	C_b	Pred C_d
270.6 - 250.0	13280	195	165	390	13670	639	204
250.0 - 230.0	13670	204	693	300	14560	639	214
230.0 - 219.0	14560	214	280	339	14960	639	220
219.0 - 199.8	14960	220	15	337	15190	448	223
199.8 - 140.1	15190	223	299	276	16360	359	231
140.1 - 110.2	16360	231	643	323	16880	436	233
110-2 - 90.2	16880	233	2117	289	1S130	134	233
90.2 - 70.0	19130	239	277	254	19420	318	239
70.0 - 3.6	19420	239	242	297	19730	414	240

e. Nitrate

Reach	Q_u	C_u	Q_t	C_t	Q_d	C_b	Pred C_d
270.6 - 250.0	13280	1.84	165	7.60	13670	0.9	1.89
250.0 - 230.0	13670	1.89	693	0.45	14560	0.9	1.81
230.0 - 219.0	14560	1.81	280	1.36	14960	0.9	1.79
219.0 - 199.8	14960	1.79	15	2.07	15190	7.2	1.87
199.8 - 140.1	15190	1.87	299	6.77	16360	16.9	2.76
140.1 - 110.2	16360	2.76	643	4.11	16880	25.9	2.64
110.2- 90.2	16880	2.64	2117	2.54	19130	5.9	2.62
90.2 - 70.0	19130	2.65	277	2.11	19420	8.8	2.65
70.0 - 3.6	19420	2.65	242	0.36	19730	5.1	2.63

f. Phosphate

Reach	Q_u	C_u	Q_t	C_t	Q_d	C_b	Pred C_d
270.6 - 250.0	13280	0.29	165	0.10	13670	0.05	0.28
250.0 - 230.0	13670	0.28	693	0.30	14560	0.05	0.28
230.0 - 219.0	14560	0.28	280	0.26	14960	0.05	0.28
219.0 - 199.8	14960	0.28	15	0.16	15190	0.05	0.28
199.8 - 140.1	15190	0.28	299	0.19	16360	0.05	0.27
140.1 - 110.2	16360	0.27	643	0.61	16880	0.05	0.28
110.2 - 90.2	16880	0.28	2117	0.47	19130	0.05	0.30
90.2 - 70.0	19130	0.30	277	0.31	19420	0.05	0.31
70.0 - 3.6	19420	0.31	242	0.27	19730	0.05	0.31

Appendix A-2. Impact of Lake Michigan Diversion on Illinois River Chemical Constituents during Average Flow Conditions — 3400 cfs Diversion

(Mass balance analysis; concentrations in mg/l; flows in cfs)

a. Chlorides .

Reach	Q_u	C_u	Q_t	C_t	Q_d	C_b	Pred C_d
270.6 - 250.0	11130	43.6	217	29.8	11680	53	43.6
250.0 - 230.0	11680	43.6	1732	39.1	13720	53	43.2
230.0 - 219.0	13720	43.2	611	26.3	14520	53	42.6
219.0 - 199.8	14520	42.6	107	17.0	15080	38	42.3
199.8 - 140.1	15080	42.3	375	20.6	17020	37	41.3
140.1 - 110.2	17020	41.3	865	20.5	18230	49	40.5
110.2 - 90.2	18230	40.5	2160	33.0	20990	39	39.7
90.2 - 70.0	20990	39.7	634	16.0	22120	28	38.8
70.0 - 3.6	22120	38.8	283	9.2	23900	35	38.2

b. Dissolved solids

Reach	Q_u	C_u	Q_t	C_t	Q_d	C_b	Pred C_d
270.6 - 250.0	11130	153	217	546	11680	859	358
250.0 - 230.0	11680	162	1732	415	13720	859	376
230.0 - 219.0	13720	174	611	460	14520	859	386
219.0 - 199.8	14520	178	107	469	15080	628	394
199.8 - 140.1	15080	181	375	444	17020	564	411
140.1 - 110.2	17020	196	865	405	18230	574	414
110.2 - 90.2	18230	198	2160	381	20990	289	407
90.2 - 70.0	20990	198	630	296	22120	119	397
70.0 - 3.6	22120	199	283	367	23900	517	404

c. Alkalinity

Reach	Q_u	C_u	Q_t	C_t	Q_d	C_b	Pred C_d
270.6 - 250.0	11130	153	217	207	11680	440	162
250.0 - 230.0	11680	162	1732	207	13720	440	174
230.0 - 219.0	13720	174	611	197	14520	440	178
219.0 - 199.8	14520	178	107	265	15080	260	181
199.8 - 140.1	15080	181	375	227	17020	338	196
140.1 - 110.2	17020	196	865	193	18230	322	198
110.2 - 90.2	18230	198	2160	214	20990	157	198
90.2 - 70.0	20990	198	630	188	22120	244	199
70.0 - 3.6	22120	199	283	248	23900	351	209

Appendix A-2 (Concluded)

d. Hardness

Reach	Q_u	C_u	Q_t	C_t	Q_d	C_b	Pred C_d
270.6 - 250.0	11130	222	217	390	11680	639	237
250.0 - 230.0	11680	237	1732	300	13720	639	254
230.0 - 219.0	13720	254	611	337	14520	639	263
219.0 - 199.8	14520	263	107	337	15080	448	269
199.8 - 140.1	15080	269	375	276	17020	359	277
140.1 - 110.2	17020	277	865	305	18230	436	281
110.2 - 90.2	18230	281	2160	289	20990	194	279
90.2 - 70.0	20990	279	634	254	22120	318	279
70.0 - 3.6	22120	279	283	297	23900	414	283

e. Nitrate

Reach	Q_u	C_u	Q_t	C_t	Q_d	C_b	Pred C_d
270.6 - 250.0	11130	2.12	217	8.55	11680	0.9	2.20
250.0 - 230.0	11680	2.20	1732	1.63	13720	0.9	2.10
230.0 - 219.0	13720	2.10	611	1.36	14520	0.9	2.05
219.0 - 199.8	14520	2.05	107	3.58	15080	7.2	2.22
199.8 - 140.1	15080	2.22	375	8.12	17020	16.9	3.70
140.1 - 110.2	17020	3.70	865	6.41	18230	25.9	4.25
110.2 - 90.2	18230	4.25	2160	2.54	20990	5.9	4.12
90.2 - 70.0	20990	4.12	634	2.11	22120	8.8	4.17
70.0 - 3.6	22120	4.17	283	0.36	23900	5,1	4.18

f. Phosphate

Reach	Q_u	C_u	Q_t	C_t	Q_d	C_b	Pred C
270.6 - 250.0	11130	0.39	217	0.11	11680	0.05	0.38
250.0 - 230.0	11680	0.38	1732	0.30	13720	0.05	0.36
230.0 - 219.0	13720	0.36	611	0.26	14520	0.05	0.35
219.0 - 199.8	14520	0.35	107	0.20	15080	0.05	0.34
199.8 - 140.1	15080	0.34	375	0.19	17020	0.05	0.31
140.1 - 110.2	17020	0.31	865	0.91	18230	0.05	0.33
110.2 - 90.2	18230	0.33	2160	0.47	20990	0.05	0.34
90.2 - 70.0	20990	0.34	634	0.31	22120	0.05	0.33
70.0 - 3.6	22120	0.33	283	0.27	23900	0.05	0.31

Appendix A-3. Impact of Lake Michigan Diversion on Illinois River Chemical Constituents during Average Conditions — 6800 cfs Diversion

(Mass balance analysis; concentrations in mg/l; flows in cfs)

a. Chlorides

Reach	Q_u	C_u	Q_t	C_t	Q_d	C_b	Pred C_d
270.6 - 250.0	14530	35.5	217	29.8	15080	53	35.8
250.0 - 230.0	15080	35.8	1732	39.1	17120	53	36.4
230.0 - 219.0	17120	36.4	611	26.3	17920	53	36.2
219.0 - 199.8	17920	36.2	107	17.0	18480	38	36.1
199.8 - 140.1	18480	36.1	375	20.6	20420	37	35.9
140.1 - 110.2	20420	35.9	865	20.5	21630	49	35.5
110.2 - 90.2	21630	35.5	2160	33.0	24390	39	35.4
90.2 - 70.0	24390	35.4	634	16.0	25520	28	34.8
70.0 - 3.6	25520	34.8	283	9.2	27310	35	34.5

b. Dissolved solids

Reach	Q_u	C_u	Q_t	C_t	Q_d	C_b	Pred C_d
270.6 - 250.0	14530	298	217	546	15080	859	314
250.0 - 230.0	15080	314	1732	415	17120	859	334
230.0 - 219.0	17120	334	611	460	17920	859	344
219.0 - 199.8	17920	344	107	469	18480	628	352
199.8 - 140.1	18480	352	375	444	20420	564	370
140.1 - 110.2	20420	370	865	405	21630	574	375
110.2 - 90.2	21630	375	2160	381	24390	289	373
90.2 - 70.0	24390	373	634	296	25520	119	366
70.0 - 3.6	25520	366	283	367	27310	517	374

c. Alkalinity

Reach	Q_u	C_u	Q_t	C_t	Q_d	C_b	Pred C_d
270.6 - 250.0	14530	145	217	207	15080	440	152
250.0 - 230.0	15080	152	1732	207	17120	440	163
230.0 - 219.0	17120	165	611	197	17920	440	167
219.0 - 199.8	17920	167	107	265	18480	260	170
199.8 - 140.1	18480	170	375	227	20420	338	184
140.1 - 110.2	20420	184	865	193	21630	322	187
110.2 - 90.2	21630	187	2160	214	24390	157	189
90.2 - 70.0	24390	18a	634	188	25520	244	190
70.0 - 3.6	25520	190	283	248	27310	351	199

Appendix A-3. (Concluded)

d. Hardness

Reach	Q_u	C_u	Q_t	C_t	Q_d	C_b	Pred C_d
270.6 - 250.0	14530	201	217	390	15080	639	213
250.0 - 230.0	15080	213	1732	300	17120	639	229
230.0 - 219.0	17120	229	611	337	17920	639	237
219.0 - 199.8	17920	237	107	337	18480	448	243
199.8 - 140.1	18480	243	375	276	20420	359	252
140.1 - 110.2	20420	252	865	305	21630	436	257
110.2 — 90.2	21630	257	2160	289	24390	194	258
90.2 - 70.0	24390	258	634	254	25520	318	259
70.0 - 3.6	25520	259	283	297	27310	414	268

e. Nitrate

Reach	Q_u	C_u	Q_t	C_t	Q_d	C_b	Pred C_d
270.6 - 250.0	14530	1.90	217	8.55	15080	0.9	1.97
250.0 - 230.0	15080	1.97	1732	1.63	17120	0.9	1.92
230.0 - 219.0	17120	1.92	611	1.36	17920	0.9	1.89
219.0 - 199.8	17920	1.89	107	3.58	18480	7.2	2.03
199.8 - 140.1	18480	2.03	375	8.12	20420	16.9	3.28
140.1 - 110.2	20420	3.28	865	6.41	21630	25.9	3.77
110.2 - 90.2	21630	3.77	2160	2.54	24390	5.9	3.71
90.2 - 70.0	24390	3,71	634	2.11	25520	8.8	3.76
70.0 - 3.6	25520	3.76	283	0.36	27310	5.1	3.80

f. Phosphate

Reach	Q_u	C_u	Q_t	C_t	Q_d	C_b	Pred C_d
270.6 - 250.0	14530	0.31	217	0.11	15080	0.05	0.30
250.0 - 230.0	15080	0.30	1732	0.30	17120	0.05	0.30
230.0 - 219.0	17120	0.30	611	0.26	17920	0.05	0.30
219.0 - 199.8	17920	0.30	107	0.20	18480	0.05	0.29
199.8 - 140.1	18480	0.29	375	0.19	20420	0.05	0.27
140.1 - 110.2	20420	0.27	865	0.91	21630	0.05	0.29
110.2 - 90.2	21630	0.29	2160	0.47	24390	0.05	0.30
90.2 - 70.0	24390	0.30	634	0.31	25520	0.05	0.30
70.0 - 3.6	25520	0.30	283	0.27	27310	0.05	0.29

Appendix A-4. Impact of Lake Michigan Diversion on Illinois River Chemical Constituents during Wet-Year Flow Conditions—3400 cfs Diversion

(Mass balance anlaysis; concentrations in mg/l; flows in cfs)

a. Chlorides

Reach	Q_u	C_u	Q_t	C_t	Q_d	C_b	Pred C_d
270.6 - 250.0	16950	48.8	699	29.8	18390	53.0	48.2
250.0 - 230.0	18390	48.2	3805	33.1	22830	53.0	45.8
230.0 - 219.0	22830	45.8	2045	26.3	25330	53.0	44.4
219.0 - 199.8	25330	44.4	301	20.1	26690	38.0	43.9
199.8 - 140.1	26690	43.9	1147	31.2	30270	37.0	42.9
140.1 - 110.2	30270	42.9	2146	21.2	33800	49.6	41.8
110.2 - 90.2	33800	41.8	7325	33.0	41790	37.0	40.2
90.2 - 70.0	41790	40.2	1544	16.0	44690	28.0	39.0
70.0 - 3.6	44690	39.0	1043	9.2	48290	35.0	38.1

b. Dissolved solids

Reach	Q_u	C_u	Q_t	C_t	Q_d	C_b	Pred C_d
270.6 - 250.0	16950	365	699	546	18390	859	392
250.0 - 230.0	18390	392	3805	415	22830	859	409
230.0 - 219.0	22830	409	2045	460	25330	859	421
219.0 - 199.8	25330	421	301	469	26690	628	430
199.8 - 140.1	26690	430	1147	519	30270	564	444
140.1 - 110.2	30270	444	2146	283	33800	574	439
110.2 - 90.2	33800	439	7325	381	41790	289	426
90.2 - 70.0	41790	426	1544	296	44690	119	412
70.0 - 3.6	44690	412	1043	367	48290	517	417

c. Alkalinity

Reach	Q_u	C_u	Q_t	C_t	Q_d	C_b	Pred C_d
270.6 - 250.0	16950	158	799	213	18390	440	171
250.0 - 230.0	18390	171	3805	207	22830	440	184
230.0 - 219.0	22830	184	2045	197	25330	440	197
219.0 - 199.8	25330	197	301	251	26690	260	200
199.8 - 140.1	26690	200	1147	227	30270	338	212
140.1 - 110.2	30270	212	2146	145	33800	322	212
110.2 - 90.2	33800	212	7325	214	41790	157	211
90.2 - 70.0	41790	211	1544	188	44690	244	211
70.0 - 3.6	44690	211	1043	248	48290	351	219

Appendix A-4. (Concluded)

d. Hardness

Reach	Q_u	C_u	Q_t	C_t	Q_d	C_b	Pred C_d
270.6 - 250.0	16950	236	699	390	18390	639	258
250.0 - 230.0	18390	258	3005	300	22830	639	276
230.0 - 219.0	22830	276	2045	334	25330	639	287
219.0 - 199.8	25330	287	301	337	26690	448	294
199.8 - 140.1	26690	294	1147	276	30270	359	299
140.1 - 110.2	30270	299	2146	219	33800	436	300
110.2 - 90.2	33800	300	7325	289	41790	194	296
30.2 - 70.0	41730	236	1544	254	44690	316	295
70.0 - 3.6	44690	295	1043	297	48290	414	301

e. Nitrate

Reach	Q_u	C_u	Q_t	C_t	Q_d	C_b	Pred C_d
270.6 - 250.0	16950	2.26	699	14.13	18390	0.9	2.66
250.0 - 230.0	18390	2.66	3805	4.00	22830	0.9	2.83
230.0 - 219.0	22830	2.83	2045	1.37	25330	0.9	2.68
219.0 - 199.8	25330	2.68	301	6.75	26690	7.2	2.91
199.8 - 140.1	26690	2.91	1147	17.26	30270	16.9	4.58
140.1 - 110.2	30270	4.58	2146	25.06	33800	25.9	6.75
110.2 - 90.2	33800	6.75	7325	2.54	41790	5.9	6.00
90.2 - 70.0	41790	6.00	1544	2.11	44690	8.8	5.95
70.0 - 3.6	44690	5.95	1043	0.36	48290	5.1	5.78

f. Phosphate

Reach	Q_u	C_u	Q_t	C_t	Q_d	C_b	Pred C_d
270.6 - 250.0	16950	0.44	699	0.13	18390	0.05	0.41
250.0 - 230.0	18390	0.41	3805	0.30	22830	0.05	0.38
230.0 - 219.0	22830	0.38	2045	0.26	25330	0.05	0.36
219.0 - 199.8	25330	0.36	301	0.33	26690	0.05	0.35
199.8 - 140.1	26690	0.35	1147	0.19	30270	0.05	0.32
140.1 - 110.2	30270	0.32	2146	8.61	33800	0.05	0.84
110.2 - 90.2	33800	0.84	7325	0.47	41790	0.05	0.76
90.2 - 70.0	41790	0.76	1544	0.31	44690	0.05	0.72
70.0 - 3.6	44690	0.72	1043	0.27	48290	0.05	0.67

Appendix A-5. Impact of Lake Michigan Diversion on Illinois River Chemical Constituents during Wet-Year Flow Conditions — 6800 cfs Diversion

(Mass balance analysis; concentrations in mg/l; flows in cfs)

a. Chlorides

Reach	Q_u	C_u	Q_t	C_t	Q_d	C_b	Pred C_d
270.6 - 250.0	20350	42.2	699	29.8	21790	53.0	42.2
250.0 - 230.0	21790	42.2	3805	33.1	26230	53.0	41.1
230.0 - 219.0	26230	41.1	2045	26.3	28730	53.0	40.2
219.0 - 199.8	28730	40.2	301	20.1	30090	38.0	39.9
199.8 - 140.1	30090	39.9	1147	31.2	33670	37.0	39.4
140.1 - 110.2	33670	39.4	2146	21.2	37200	49.0	38.7
110.2 - 90.2	37200	38.7	7325	33.0	45190	39.0	37.8
90.2 - 70.0	45190	37.8	1544	16.0	48090	28.0	36.8
70.0 - 3.6	48090	36.8	1043	9.2	51690	35.0	36.2

b. Dissolved Solids

Reach	Q_u	C_u	Q_t	C_t	Q_d	C_b	Pred C_d
270.6 - 250.0	20350	331	699	546	21790	859	356
250.0 - 230.0	21790	356	3805	415	26230	859	377
230.0 - 219.0	26230	377	2045	460	28730	859	391
219.0 - 199.8	28730	391	301	469	30090	628	400
199.8 - 140.1	30090	400	1147	519	33670	564	416
140.1 - 110.2	33670	416	2146	283	37200	574	414
110.2 - 90.2	37200	414	7325	381	45190	289	407
90.2 - 70.0	45190	407	1544	296	48090	119	395
70.0 - 3.6	48090	395	1043	367	51690	517	400

c. Alkalinity

Reach	Q_u	C_u	Q_t	C_t	Q_d	C_b	Pred C_d
270.6 - 250.0	20350	151	699	213	21790	440	163
250.0 - 230.0	21790	163	3805	207	26230	440	176
230.0 - 219.0	26230	176	2045	197	28730	440	182
219.0 - 199.8	28730	182	301	251	30090	260	185
199.8 - 140.1	30090	185	1147	227	33670	338	197
140.1 - 110.2	33670	197	2146	145	37200	322	199
110.2 - 90.2	37200	199	7325	214	45190	157	201
90.2 - 70.0	45190	201	1544	188	48090	244	202
70.0 - 3.6	48090	202	1043	249	51690	351	210

Appendix A-5. (Concluded)

d. Hardness

Reach	Q_u	C_u	Q_t	C_t	Q_d	C_b	Pred C_d
270.6 - 250.0	20350	219	699	390	21790	639	239
250.0 - 230.0	21790	239	3805	300	26230	639	258
230.0 - 219.0	26230	258	2045	334	28730	639	269
219.0 - 199.8	28730	269	301	337	30090	448	276
199.8 - 140.1	30090	276	1147	276	33670	359	282
140.1 - 110.2	33670	282	2146	219	37200	436	284
110.2 - 50.2	37200	284	7325	289	45190	134	283
90.2 - 70.2	45190	283	1544	254	48090	318	283
70.0 - 3.6	48090	290	1043	297	51690	414	290

e. Nitrates

Reach	Q_u	C_u	Q_t	C_t	Q_d	C_b	Pred C_d
270.6 - 250.0	20350	2.08	699	14.13	21790	0.9	2.43
250.0 - 230.0	21790	2.43	3805	4.50	26230	0.9	2.62
230.0 - 219.0	26230	2.62	2045	1.37	28730	0.9	2.5-
219.0 r- 199.8	28730	2.50	301	6.75	30090	7.2	2.71
199.8 - 140.1	30090	2.71	1147	17.26	33670	16.9	4.23
140.1 - 110.2	33670	4.23	2146	25.06	37200	25.9	6.24
110.2 - 90.2	37200	6.24	7325	2.54	45190	5.9	5.64
90.2 - 70.2	45190	5.64	1544	2.11	48090	8.8	5.62
70.2 - 3.6	48090	5.62	1043	0.36	51690	5.1	5.49

f. Nitrates

Reach	Q_u	C_u	Q_t	C_t	Q_d	C_b	Pred C_d
270.6 - 250.0	20350	0.38	699	0.13	21790	0.05	0.36
250.0 - 230.0	21790	0.36	3805	0.30	26230	0.05	0.34
230.0 - 219.0	26230	0.34	2045	0.26	28730	0.05	0.33
219.0 - 199.8	28730	0.33	301	0.33	30090	0.05	0.32
199.8 - 140.1	30090	0.32	1147	0.19	33670	0.05	0.30
140.1 - 110.2	33670	0.30	2146	8.61	37200	0.05	0.77
110.2 - 90.2	37200	0.77	7325	0.47	45190	0.05	0.71
90.2 - 70.2	45190	0.71	1544	0.31	48090	0.05	0.68
70.2 - 3.6	48090	0.68	1043	0.27	51690	0.05	0.64

Appendix B-1. Physical and Chemical Data for Illinois Waterway, 1978

ILLINOIS WATERWAY, TEMPERATURE, °C

DATE	07/18/78	07/25/78	08/15/78	08/29/78	09/05/78	09/12/78	09/19/78	09/26/78
MILE POINT								
3.6	27.50	26.50		25.10	25.70	25.70	25.10	19.90
5.5	27.30	26.80		25.10	25.70	25.80	26.10	20.00
8.3	27.40	27.80		24.80	25.90	26.10	25.70	20.00
10.3	27.60	26.80		24.70	25.20	25.90	25.00	20.00
12.1	27.40	27.10		25.10	25.40	26.00	25.40	20.10
14.0	27.30	27.10		24.80	26.50	26.10	25.00	20.00
16.5	27.10	27.30		26.00	26.50	26.10	25.50	19.80
18.0	27.20	27.00		25.00	26.50	26.00	25.20	20.00
20.7	27.10	26.80		24.80	26.00	25.80	25.70	19.80
22.8	27.10	27.00		25.50	26.20	25.60	25.50	19.80
24.4	27.10	27.10		25.60	25.50	25.50	25.50	19.80
26.0	27.10	27.00		25.30	26.00	25.50	25.80	19.70
28.2	27.30	27.00		25.00	25.90	25.40	26.00	19.50
30.6	27.40	26.90		24.70	25.60	25.80	25.90	19.40
32.1	27.20	27.00		25.40	25.90	25.80	26.30	19.50
34.2	27.50	27.00		25.60	26.00	25.50	25.80	19.40
36.3	27.20	26.90		24.90	25.30	25.50	25.80	19.40
38.0	27.10	26.90		25.10	25.80	25.80	25.90	19.50
39.3	27.10	26.80		24.70	25.20	25.90	25.70	19.60
41.9	27.10	26.90		24.80	25.50	26.20	26.30	19.50
44.1	27.00	26.60		24.60	25.40	25.80	26.20	19.30
46.1	27.10	26.80		24.70	25.50	25.50	26.10	19.50
47.8	27.00	26.70		24.60	25.40	25.80	26.00	19.70
50.0	27.20	26.70		24.80	25.50	25.80	26.20	19.80
52.1	26.90	26.70		24.80	25.70	25.50	26.20	19.50
54.2	27.00	26.70		24.90	25.90	25.80	26.10	19.50
56.0	26.90	26.60		24.80	25.30	25.80	25.90	19.30
57.8	27.00	26.60		24.50	25.10	25.80	25.50	19.50
60.8	27.10	26.60		24.70	25.50	26.00	25.70	19.20
62.4	26.80	26.60		24.50	25.20	25.80	25.60	19.10
64.4	26.80	26.70		24.50	25.80	25.80	25.80	19.00
66.6	26.90	26.60		24.50	25.60	25.50	25.30	19.10
68.4	26.90	26.60		24.50	25.50	25.50	25.70	19.00
70.0	27.50	26.90		24.90	25.60	25.80	26.10	19.50
71.7	26.80	26.50		24.40	25.40	25.50	25.60	18.90
74.5	26.70	26.60		24.40	25.40	25.50	25.80	19.00
75.9	26.80	26.40		24.40	25.20	25.50	25.40	19.00
78.4	26.80	26.40		24.30	25.10	25.50	25.40	18.70
80.2	26.60	26.60		24.20	25.70	25.50	25.60	18.90
82.3	26.80	26.60		24.00	25.20	25.50	25.50	18.90
84.1	26.70	26.60		24.00	25.40	25.50	25.90	18.60
86.0	26.50	26.80		24.20	25.10	25.20	25.60	18.80
87.9	26.70	26.80		24.30	25.10	25.20	25.60	18.80
90.2	26.90	26.60		25.00	25.20	26.20	25.50	19.90
91.5	26.80	25.80		24.90	24.40	26.20	25.20	19.80
94.3	26.80	25.80		24.80	24.30	26.00	25.00	19.70
95.8		25.70		24.90	24.30	26.00	25.00	19.80
98.2	26.90	25.70		24.70	24.40	26.00	25.00	20.10
100.9	26.80	25.60		25.00	24.60	26.00	25.00	19.80
102.8	26.80	25.50		25.00	24.40	26.60	24.90	19.90
104.0	26.70	25.30		25.00	24.60	26.60	25.00	19.80
105.5	26.90	25.40		25.00	24.40	26.20		19.90
108.2	26.80	25.30		25.00	24.50	26.00	24.90	19.60
110.2	26.80	25.30		25.00	24.50	25.80	24.80	19.80
111.8	26.70	25.20		25.00	24.50	25.80	25.00	19.70
114.3	26.80	25.30		24.70	24.50	25.50	24.90	19.70
116.3	26.70	25.30		24.70	24.50	25.80	25.00	19.50
118.0	26.40	25.40		24.80	25.10	26.80	24.80	19.60
119.9	26.60	25.50		24.60	24.50	27.00	25.00	19.60
121.8	26.40	25.60		24.70	24.60	27.20	24.90	20.00
123.6	26.30	25.50		25.10	24.50	27.20	24.90	19.70
125.8	26.40	25.70		24.60	24.90	27.00	25.00	19.90
128.1	26.40	25.60		24.80	24.80	27.00	25.00	19.80
129.9	26.20	25.60		24.80	24.80	26.80	25.00	19.80
132.0	26.10	25.60		24.80	25.00	26.80	25.00	19.90
134.0	26.10	25.50		24.80	24.90	26.80	24.90	19.90
135.7	25.60	25.40		24.70	25.00	27.00	25.00	20.00
137.5	25.80	25.50		25.00	25.10	27.20	25.00	20.10
140.1	26.10	25.50		24.70	25.10	27.20	25.00	19.70
143.2	25.90	26.00		24.60	25.10	27.20	25.10	19.50
145.5	25.60	25.70		24.60	25.00	27.00	25.00	19.50
147.3	25.60	25.80		25.50	25.30	27.00	24.90	19.40
148.2	25.70	25.90		24.70	25.50	27.00	24.90	19.60
150.2	25.70	26.10		24.70	25.40	26.30	25.10	19.50
152.2	25.40	26.30		24.50	25.50	27.00	24.90	19.50
154.2	25.40	26.40		24.20	25.50	25.00	24.60	19.30
156.5	24.90	25.50		24.20	25.30	25.20	24.50	
158.0	25.10	25.90	26.40	24.20	25.90	25.20	24.50	18.60
159.9	25.10	25.80	25.80	24.20	25.60	25.20	24.50	18.70
162.0	25.10	25.80	25.00	23.90	25.50	25.00	24.40	18.60

Appendix B-1. (Continued)

ILLINOIS WATERWAY, TEMPERATURE, °C

DATE	07/18/78	07/25/78	03/15/78	08/29/78	09/05/78	09/12/78	09/19/73	09/26/78
MILE POINT								
163.9	25.10	25.40	25.60	23.90	25.80	24.80	24.90	18.50
166.1	24.90	25.50	25.90	23.80	25.50	25.20	24.50	19.90
167.9	24.70	25.50	25.80	24.00	24.90	25.40	21.30	19.70
170.9	24.40	25.70	25.30	23.90	26.20	25.50	21.30	19.60
173.2	24.80	25.50	25.40	24.00	25.40	25.60	21.20	20.00
174.9	25.00	25.50	25.90	24.20	26.10	25.90	22.60	20.00
176.6	25.00	25.40	25.80	24.50	25.50	26.10	22.50	19.90
179.0	24.90	25.20	25.50	24.40	25.40	26.20	22.50	19.80
179.9	24.90	25.20	25.90	25.00	24.80	26.40	22.50	19.80
181.9	24.90	24.60	25.70	24.80	24.40	26.30	22.40	19.60
184.1	24.80	24.40	25.80	25.50	24.60	26.20	22.00	19.30
186.4	24.80	24.20	25.90	24.80	24.50	26.30	22.00	19.40
187.9	24.80	24.30	26.10	25.60	24.40	26.30	22.20	19.50
190.0	24.70	24.30	26.20	25.10	24.90	26.20	22.20	19.80
191.6	24.70	24.40	26.00	26.10	25.00	26.30	21.80	19.60
194.1	25.00	24.70	26.00	24.90	24.90	26.50	21.50	19.80
196.0	25.20	24.40	25.90	24.70	24.80	26.50	21.80	20.00
198.1	25.20	24.70	26.70	25.30	25.00	26.70	22.00	20.20
199.8	25.10	24.60	26.80	25.80	25.20	26.80	22.00	20.50
202.5	25.00	24.60	26.40	25.00	25.50	27.00	21.80	19.80
204.0	25.30	24.50	25.30	25.20	25.60	26.90	22.10	19.80
206.0	25.40	24.30	26.30	24.20	25.50	26.80	22.00	19.60
208.0	25.90	24.80	26.10	25.00	25.40	27.10	21.70	19.80
210.2	26.20	24.70	26.20	25.10	25.00	27.40	22.50	19.80
212.0	25.60	24.30	25.80	24.60	25.00	26.50	22.30	19.80
213.8	25.40	24.20	25.80	24.80	25.00	26.30	22.00	19.40
215.7	25.40	24.00	26.00	24.50	25.00	26.60	22.10	19.90
218.4	25.20	24.20	25.90	24.50	25.30	26.40	22.20	20.00
219.8	25.60	24.10	26.20	25.00	25.10	26.40	22.40	19.80
222.0	25.30	23.90	25.30	24.40	25.20	26.50	22.00	19.40
223.9	25.20	23.90	25.50	24.60	25.50	26.50	21.90	19.70
225.8	25.50	24.00	24.90	24.20	25.40	26.40	21.70	19.40
228.0	25.60	24.00	25.50	24.30	25.10	26.50	21.80	19.80
230.1	26.40	24.30	26.60	25.00	24.90	26.50	22.00	20.20
231.7	25.30	24.80	27.20	25.00	26.70	26.80	22.00	20.00
234.2	25.20	24.60	27.20	24.50	26.50	27.20	21.60	19.60
236.2	25.10	24.70	27.30	24.30	26.20	27.10	21.80	19.80
237.9	25.00	24.60	27.00	24.50	26.20	27.00	21.60	19.60
239.6	24.90	25.20	25.60	25.70	25.90	27.40	22.50	20.60
242.0	25.60	25.50	27.90	24.90	25.90	27.40	22.70	20.60
244.0	25.90	25.20	28.20	25.60	26.00	27.40	22.80	20.70
247.8	25.80	25.40	27.60	25.30	26.50	27.40	23.20	20.60
250.0	25.90	25.50	27.50	25.80	26.50	27.50	23.40	20.60
251.8	25.70	25.20	27.60	25.40	26.60	27.40	23.80	20.40
254.0	25.70	25.30	27.70	25.40	26.80	27.50	23.70	20.40
256.0	25.60	25.20	26.80	25.60	26.60	27.70	23.20	20.50
258.0	25.80	25.20	27.40		26.80	27.60	23.40	20.40
260.4	25.80	25.30	27.30	25.90	26.90	27.50	23.50	20.40
262.3	25.70	25.40	27.20	25.40	27.00	27.60	23.70	20.30
264.0	25.90	25.50	27.20	25.30	27.20	27.70	23.70	20.30
265.8	26.40	25.40	27.20	25.20	27.30	27.60	23.60	20.50
268.9	26.10	25.10	27.50	25.20	27.40	27.50	23.40	20.60
270.6	25.70	25.00	27.60	25.60	27.40	27.50	22.80	20.90

Appendix B-1. (Continued)

TEMPERATURE (CELSIUS)

DATE	07/18/78	07/25/78	08/15/78	08/29/78	09/05/78	09/12/78	09/19/78	09/26/78
MILE POINT								
3.6	27.50	26.50		25.10	25.70	25.70	25.10	19.90
10.3	27.60	26.80		24.70	25.20	25.90	25.00	20.00
20.7	27.10	26.80		24.80	26.00	25.80	25.70	19.80
30.6	27.40	26.90		24.70	25.60	25.80	25.90	- 19.40
39.3	27.10	26.80		24.70	25.20	25.80	25.70	19.60
50.0	27.20	26.70		24.80	25.50	25.80	26.20	19.80
60.8	27.10	26.60		24.70	25.50	26.00	25.70	19.20
70.0	27.50	26.90		24.90	25.60	25.80	26.10	19.50
80.2	26.60	26.60		24.20	25.70	25.50	25.60	18.90
90.2	26.90	26.60		25.00	25.20	26.20	25.50	19.90
100.9	26.80	25.60		25.00	24.60	26.00	25.00	19.80
110.2	26.80	25.30		25.00	24.50	25.80	24.80	19.80
119.9	26.60	25.50		24.60	24.50	27.00	25.00	19.60
129.9	26.20	25.60		24.80	24.80	26.80	25.00	19.80
140.1	26.10	25.50		24.70	25.10	27.20	25.00	19.70
150.2	25.70	26.10		24.70	25.40	26.30	25.10	19.50
159.9	25.10	25.80	25.80	24.20	25.60	25.20	24.50	18.70
170.9	24.40	25.70	25.30	23.90	26.20	25.50	21.30	19.60
179.9	24.90	25.20	25.90	25.00	24.80	26.40	22.50	19.80
190.0	24.70	24.30	26.10	25.10	24.90	26.20	22.20	19.80
199.8	25.10	24.60	26.80	25.80	25.20	26.80	22.00	20.50
210.2	26.20	24.70	26.20	25.10	25.00	27.40	22.50	19.80
219.8	25.60	24.10	26.20	25.00	25.10	26.40	22.40	19.80
230.1	26.40	24.30	26.60	25.00	24.90	26.50	22.00	20.20
239.6	24.90	25.20	25.60	25.70	25.90	27.40	22.50	20.60
250.0	25.90	25.50	27.50	25.80	26.50	27.50	23.40	20.60
260.4	25.80	25.30	27.30	25.90	26.90	27.50	23.50	20.40
270.6	25.70	25.00	27.60	25.60	27.40	27.50	22.80	20.90

Appendix B-1. (Continued)

TURBIDITY <NTU)

DATE	07/18/78	07/25/78	08/15/78	08/29/78	09/05/78	09/12/78	09/19/78	09/26/78
MILE POINT								
3.6	16.40	18.00		14.20	15.20	5.30	2.1.70	38.40
10.3	13.50	19.00		19.40	21.40	3.80	36.50	44.60
20.7	24.40	14.50		36.00	12.30	5.30	51.70	65.30
30.6	43.80	25.00		32.00	18.50	10.70	36.50	47.60
39.3	31.20	19.00		33.00	25.90	9.20	51.70	69.20
50.0	28.30	27.50		22.20	18.00	13.80	47.50	59.90
60.8	24.10	23.50		13.00	16.30	16.90	65.50	42.30
70.0	23.20	24.50		13.10	16.90	13.80	39.90	43.00
80.2	31.70	15.50		13.10	9.50	1.7.00	42.70	45.30
90.2	35.70	36.50		15.40	7.30	24.00	44.80	59.90
100.9	33.70	31.00		13.70	5.60	22.30	42.00	55.30
110.2	31.70	27.00		22.20	5.60	20.00	5.9.90	49.90
119.9	25.40	17.50		17.10	9.00	24.00	46.80	43.80
129.9	26.70	23.50		14.20	6.70	18.40	55.10	39.90
140.1	29.40	14.50		13.10	8.40	23.00	42.70	35.30
150.2	29.00	22.50		10.80	7.80	13.00	48.20	36.10
159.9	28.50	18.00	18.30	9.10	11.40	6.90	48.90	32.30
170.9	30.20	17.00	18.30	10.80	10.70	33.40	53.70	38.40.
179.9	26.10	17.50	14.40	10.20	19.20	18.90	131.00	36.90
190.0	20.80	17.00	15.50	7.00	12.10	21.80	57.20	35.30
199.8	27.60	10.10	16.60	7.90	16.40	16.70	64.80	16.10
210.2	15.70	12.20	12.70	7.00	16.40	15.90	131.00	17.60
219.8	21.30	18.60	12.20	3.40	18.50	17.40	45.50	14.60
230.1	13.70	21.30	11.60	5.70	19.20	15.90	46.20	14.60
239.6	12.30	7.90	7.50	8.50	8.50	13.00	23.40	6.90
250.0	12.20	21.30	8.00	10.20	9.90	1.0.90	26.20	8.40
260.4	10.60	17.00	12.50	8.00	12.10	17.40	24.80	12.30
270.6	12.90	17.00	15.50	1.14	15.70	9.40	22.00	11.50

Appendix B-1. (Continued)

DISSOLVED OXYGEN (MG/L)

DATE	07/18/78	07/25/78	08/15/78	08/29/78	09/05/78	09/12/78	09/19/78	09/26/78
MILE POINT								
3.6	2.80	2.75		3.70	4.90	5.60	3.10	4.90
10.3	4.80	3.00		3.10	4.00	5.60	2.80	4.30
20.7	4.70		2.80	2.70	4.30	5.00	3.00	4.60
30.6	4.90	2.90		2.90	3.90	5.00	3.05	4.30
39.3	4.90	3.00		2.90	3.50	4.50	3.00	4.25
50.0	4.50	3.00		3.60	4.20	4.80	3.40	4.45
60.8	4.80	3.60		4.00	4.50	4.40	3.40	5.20
70.0	5.00	3.60		4.60	5.20	4.90	3.70	5.50
80.2	4.70	4.45		3.30	7.30	2.80	3.00	5.50
90.2	4.85	4.70		3.50	9.20	2.40	3.05	4.90
100.9	4.90	5.00		3.90	8.40	2.80	3.40	5.20
110.2	5.40	4.80		4.40	8.80	2.70	3.70	5.50
119.9	5.30	5.50		4.50	8.00	3.00	3.70	4.60
129.9	4.70	5.80		5.00	8.50	3.70	4.20	5.10
140.1	5.10	5.20		5.50	8.30	3.00	4.50	5.20
150.2	5.00	5.85		10.90	8.20	4.10	4.60	5.40
159.9	5.20	5.20	5.30	5.50	11.50	3.60	4.60	5.50
170.9	5.40	5.30	5.80	7.10	12.80	6.40	4.75	5.70
179.9	5.60	4.80	5.20	8.20	4.70	5.30	4.50	6.05
190.0	5.40	4.30	5.85	10.40	5.60	5.70	4.80	6.40
199.8	5.90	5.30	6.20	12.40	5.80	5.20	4.85	7.35
210.2	7.20	5.70	5.80	10.10	6.40	5.50	5.40	7.90
219.8	7.35	5.80	6.20	8.90	6.20	5.70	5.90	7.60
230.1	7.65	5.90	6.60	8.50	7.30	6.40	6.60	7.90
239.6	8.20	5.25	5.20	5.90	5.70	4.90	5.60	5.90
250.0	5.70	4.70	5.20	5.50	6.00	5.00	3.70	6.00
260.4	5.90	5.40	5.50	5.60	6.00	4.70	5.70	6.30
270.6	6.65	5.80	6.10	6.50	6.60	5.80	6.70	6.80

Appendix B-1. (Continued)

TOTAL CHLORIDE (MG/L)

DATE	07/18/78	07/25/78	08/15/78	08/29/78	09/05/78	09/12/78	09/19/78	09/26/78
MILE POINT								
3.6	41.20	34.90		50.90	53.30	53.30	46.00	43.60
10.3	41.20	35.40		46.00	53.30	53.30	43.60	36.30
20.7	41.20	34.90		46.00	46.00	48.50	43.60	33.90
30.6	38.80	36.90		50.90	48.50	48.50	50.90	36.30
39.3	34.90	35.90		50.90	50.90	53.30	55.70	36.30
50.0	41.20	36.90		50.90	46.00	53.30	58.20	38.80
60.8	38.80	36.90		55.70	53.30	48.50	53.30	38.80
70.0	38.80	39.30		55.70	48.50	50.90	55.70	33.90
80.2	39.80	37.80		50.90	48.50	48.50	63.00	38.80
90.2	41.20	39.80		50.90	46.00	48.50	58.20	38.80
100.9	38.80	42.20		53.30	53.30	53.30	50.90	36.30
110.2	38.80	41.70		58.20	48.50	53.30	53.30	38.80
119.9	38.80	42.70		55.70	48.50	50.90	53.30	38.80
129.9	40.20	47.00		55.70	46.00	48.50	48.50	38.80
140.1	41.20	49.50		60.60	50.90	53.30	53.30	41.20
150.2	41.20	54.30		60.60	50.90	55.70	48.50	38.80
159.9	41.20	53.80	55.70	55.70	53.30	48.50	43.60	33.90
170.9	37.30	53.40	53.30	50.90	48.50	60.60	33.90	38.80
179.9	38.80	47.00	50.90	58.20	50.90	60.60	38.80	38.80
190.0	38.80	46.60	53.30	48.50	48.50	63.00	50.90	38.80
199.8	43.60	47.50	53.30	50.90	48.50	63.00	33.90	41.20
210.2	45.10	45.60	58.20	50.90	53.30	65.40	36.30	43.60
219.8	48.00	45.10	55.70	48.50	50.90	58.20	36.30	46.00
230.1	50.90	51.90	57.20	50.90	53.30	60.60	38.80	46.00
239.6	44.10	61.60	63.00	55.70	55.70	60.60	58.20	53.30
250.0	54.30	59.20	55.20	53.30	58.20	58.20	46.00	50.90
260.4	57.20	58.70	58.20	55.70	55.70	58.20	46.00	48.50
270.6	49.50	60.10	60.10	55.70	58.20	60.60	48.50	53.30

Appendix B-1. (Continued)

PH

DATE	07/18/78	07/25/78	08/15/78	08/29/78	09/05/78	09/12/78	09/19/78	09/26/78
MILE POINT								
3.6	8.17	8.17		7.89	8.22	8.58	8.12	7.89
10.3	8.12	7.92		7.89	8.28	8.57	7.94	7.85
20.7	8.12	7.69		7.81	8.31	8.50	7.93	7.86
30.6	8.09	7.98		7.96	8.18	8.46	8.04	8.04
39.3	fl.05	8.02		7.91	8.16	8.29	8.07	7.88
50.0	8.01	8.11		7.96	8.22	8.23	8.03	7.96
60.8	8.08	8.30		8.08	8.25	8.18	8.40	8.07
70.0	8.12	8.25		8.13	8.33	8.08	8.15	8.05
80.2	8.19	8.37		7.99	8.77	R.05	7.98	8.15
90.2	8.03	8.22		8.12	8.90	8.07	8.08	8.19
100.9	8.08	8.30		8.15	9.11	8.17	8.09	8.21
110.2	7.92	8.31		8.15	9.02	8.23	7.97	8.36
119.9	7.96	8.34		8.17	9.15	8.40	8.09	8.36
129.9	8.08	8.40		8.20	9.18	8.37	8.06	8.05
140.1	8.35	8.30		8.43	9.13	8.11	8.09	8.12
150.2	8.01	8.19		8.49	9.18	8.11	8.02	8.18
159.9	8.48	8.09	8.16	7.89	9.27	8.39	7.98	8.30
170.9	8.54	7.57	8.31	8.41	9.18	8.35	7.85	8.00
179.9	8.12	7.92	8.20	8.33	8.32	8.23	7.77	7.93
190.0	7.95	8.01	8.34	8.57	8.38	8.19	7.86	8.05
199.8	8.10	7.97	8.40	8.83	8.43	8.18	7.81	8.13
210.2	8.04	8.00	8.38	8.77	8.41	8.32	7.81	8.30
219.8	8.09	8.01	8.52	8.68	8.45	8.18	7.84	8.21
230.1	8.14	7.92	8.61	8.68	8.37	8.21	7.84	8.17
239.6	8.34	7.82	7.84	7.98	8.03	7.95	7.68	7.84
250.0	8.05	7.80	7.75	7.84	7.92	8.05	7.66	7.86
260.4	7.87	7.81	8.12	7.81	7.88	8.07	7.68	7.84
270.6	8.03	7.82	8.11	7.97	7.92	8.04	7.64	7.80

Appendix B-1. (Continued)

TOTAL ALKALINITY AS CACOB (MG/L)

DATE	07/18/78	07/25/78	08/15/78	08/29/78	09/05/78	09/12/78	09/19/78	09/26/78
MILE POINT								
3.6	169.00	175.00		170.00	180.00	176.00	158.00	139.00
10.3	184.00	168.00		164.00	180.00	172.00	154.00	135.00
20.7	184.00	168.00		168.00	178.00	166.00	150.00	144.00
30.6	185.00	175.00		168.00	176.00	164.00	166.00	139.00
39.3	184.00	223.00		174.00	176.00	168.00	170.00	144.00
50.0	182.00	129.00		168.00	176.00	170.00	172.00	148.00
60.8	178.00	184.00		172.00	180.00	176.00	164.00	148.00
70.0	178.00	184.00		172.00	176.00	170.00	174.00	148.00
80.2	178.00	189.00		174.00	178.00	172.00	170.00	154.00
90.2	178.00	193.00		170.00	172.00	172.00	162.00	148.00
100.9	179.00	184.00		174.00	176.00	170.00	158.00	150.00
110.2	176.00	191.00		172.00	168.00	172.00	160.00	152.00
119.9	179.00	179.00		176.00	164.00	168.00	156.00	150.00
129.9	179.00	179.00		174.00	154.00	166.00	148.00	150.00
140.1	178.00	179.00		174.00	158.00	166.00	148.00	152.00
150.2	178.00	168.00		174.00	150.00	170.00	148.00	154.00
159.9	175.00	163.00	160.00	162.00	156.00	164.00	139.00	154.00
170.9	156.00	138.00	187.00	166.00	148.00	205.00	129.00	156.00
179.9	180.00	143.00	172.00	170.00	164.00	205.00	131.00	164.00
190.0	183.00	152.00	164.00	166.00	158.00	205.00	133.00	166.00
199.8	176.00	150.00	160.00	164.00	160.00	205.00	129.00	170.00
210.2	178.00	150.00	162.00	164.00	156.00	201.00	127.00	176.00
219.8	184.00	150.00	158.00	164.00	156.00	162.00	137.00	176.00
230.1	177.00	152.00	156.00	162.00.	160.00	156.00	148.00	176.00
239.6	193.00	147.00	160.00	144.00	156.00	154.00	125.00	154.00
250.0	174.00	147.00	154.00	137.00	156.00	154.00	127.00	158.00
260.4	169.00	152.00	162.00	144.00	152.00	154.00	125.00	160.00
270.6	166.00	152.00	164.00	150.00	160.00	150.00	127.00	197.00

Appendix B-1. (Continued)

TOTAL HARDNESS (MG/L)

DATE	07/18/78	07/25/78	08/15/78	08/29/78	09/05/78	09/12/78	09/19/78	09/26/78
MILE POINT								
3.6	287.00	310.00		297.00	323.00	297.00	257.00	267.00
10.3	297.00	337.00		310.00	323.00	300.00	294.00	273.00
20.7	297.00	330.00		277.00	323.00	277.00	287.00	271.00
30.6	297.00	290.00		304.00	310.00	300.00	290.00	244.00
39.3	297.00	290.00		231.00	310.00	290.00	257.00	221.00
50.0	295.00	290.00		271.00	304.00	284.00	310.00	271.00
60.8	293.00	317.00		310.00	317.00	304.00	304.00	271.00
70.0	285.00	317.00		297.00	227.00	297.00	287.00	251.00
80.2	287.00	323.00		304.00	297.00	297.00	317.00	264.00
90.2	287.00	337.00		267.00	284.00	310.00	310.00	271.00
100.9	292.00	363.00		304.00	310.00	304.00	320.00	271.00
110.2	294.00	363.00		284.00	290.00	297.00	290.00	238.00
119.9	297.00	350.00		277.00	271.00	251.00	290.00	277.00
129.9	295.00	337.00		264.00	264.00	277.00	287.00	257.00
140.1	291.00	330.00		304.00	244.00	290.00	277.00	284.00
150.2	291.00	304.00		284.00	264.00	244.00	287.00	271.00
159.9	290.00	317.00	264.00	304.00	227.00	284.00	271.00	251.00
170.9	290.00	284.00	264.00	251.00	264.00	277.00	244.00	294.00
179.9	294.00	284.00	277.00	297.00	307.00	277.00	224.00	294.00
190.0	302.00	277.00	257.00	330.00	287.00	290.00	257.00	300.00
199.8	297.00	284.00	257.00	297.00	271.00	257.00	254.00	304.00
210.2	303.00	277.00	257.00	297.00	257.00	277.00	267.00	290.00
219.8	302.00	297.00	251.00	310.00	264.00	304.00	277.00	304.00
230.1	297.00	271.00	251.00	244.00	264.00	284.00	234.00	307.00
239.6	317.00	277.00	284.00	264.00	297.00	277.00	215.00	244.00
250.0	300.00	271.00	290.00	271.00	297.00	264.00	251.00	248.00
260.4	287.00	277.00	271.00	257.00	284.00	251.00	251.00	244.00
270.6	260.00	317.00	257.00	257.00	264.00	244.00	254.00	257.00

Appendix B-1. (Continued)

AMMONIA-NITROGEN (MG/L)

DATE	07/18/78	07/25/78	08/15/78	08/29/78	09/05/78	09/12/78	09/19/78	09/26/78
MILE POINT								
3.6	.05	.02		0.00	.01	.01	0.00	.02
10.3	.04	.02		0.00	0.00	0.00	.02	.01
20.7	.06	.02		0.00	0.00	.01	0.00	0.00
30.6	.05	.03		0.00	.01	.02	0.00	.01
39.3	.11	.05		0.00	.01	.07	.03	.02
50.0	.08	.03		0.00	.01	.07	.02	.01
60.8	.08	.01		0.00	0.00	.21	0.00	.03
70.0	.08	0.00		0.00	.06	.16	.06	.01
80.2	.06	.04		0.00	.01	.24	.03	0.00
90.2.	.05	.03		0.00	0.00	.31	.09	.01
100.9	.07	.06		.01	.04	.30	.17	.02
110.2	.10	.01		.03	.05	.30	.07	.03
119.9	.11	.01		.04	.09	.39	.18	.06
129.9	.07	.04		.03	.19	.61	.17	.16
140.1	.09	.03		.03	.22	.51	.20	.09
150.2	.08	.05		.07	.20	.36	.14	.08
159.9	.06	.05	0.00	.22	.04	.19	.18	.08
170.9	.07	.12	.07	.03	.01	.01	.23	.13
179.9	.06	.22	.16	.08	.14	.02	.16	.12
190.0	.06	.18	.12	0.00	0.00	.02	.14	.13
199.8	.15	.17	.12	.01	0.00	.17	.19	.14
210.2	.12	.15	.35	0.00	.01	.15	.12	.16
219.8	.15	.20	.35	.09	0.00	.19	.17	.18
230.1	.22	.24	.43	.15	.13	.31	.21	.23
239.6	.19	.58	.45	.40	.48	.58	.31	.45
250.0	.63	.89	.67	.49	.55	.54	.58	.51
260.4	.70	.76	.93	.50	.81	.73	.55	.58
270.6	.62	1.07	.90	.65	1.16	1.05	.65	.60

Appendix B-1. (Continued)

NITRATE-NITROGEN (MG/L)

DATE	07/18/78	07/25/78	08/15/78	08/29/78	09/05/78	09/12/78	09/19/78	09/26/78
MILE POINT								
3.6	2.90	2.30		2.12	1.91	.88	1.34	2.66
10.3	3.02	2.35		1.99	1.86	.82	1.46	2.81
20.7	2.89	2.17		1.91	1.68	.85	1.49	2.87
30.6	2.78	2.43		1.83	1.65	.80	1.75	2.91
39.3	2.75	2.49		1.78	1.57	.85	1.75	3.01
50.0	2.82	2.64		1.70	1.49	.94	1.70	2.90
60.8	2.72	2.49		1.75	1.43	.81	1.66	2.79
70.0	2.62	2.57		1.65	1.32	1.03	1.77	2.75
80.2	2.75	2.42		1.76	1.23	.95	1.87	2.69
90.2	2.97	2.61		1.81	1.06	1.04	2.34	2.82
100.9	2.87	2.72		1.83	.88	1.05	2.28	2.86
110.2	2.89	2.69		1.68	.82	.95	2.34	2.75
119.9	2.87	2.56		1.68	.80	.85	2.36	2.81
129.9	2.79	2.68		1.68	.72	.91	2.45	2.98
140.1	2.86	2.61		1.58	.73	1.13	2.42	2.90
150.2	2.69	2.78		1.52	.77	1.20	2.50	2.97
159.9	2.85	2.78	1.79	.90	.84	1.24	2.41	3.16
170.9	2.97	2.64	2.38	1.47	1.08	1.28	2.54	3.14
179.9	2.61	2.46	2.46	1.26	1.64	1.19	2.66	3.19
190.0	3.17	2.15	2.71	1.42	1.75	2.01	2.76	3.15
199.8	3.61	2.26	2.67	1.54	2.04	2.14	3.06	3.03
210.2	3.17	2.12	2.52	1.63	1.96	2.24	3.01	3.16
219.8	2.94	2.19	2.41	1.83	1.80	2.37	3.14	3.03
230.1	2.72	2.14	2.05	1.57	2.01	2.30	3.10	2.88
239.6	2.33	2.22	2.24	2.35	1.85	2.56	2.51	2.56
250.0	2.12	2.01	1.82	2.16	2.17	2.58	2.68	2.50
260.4	2.51	2.12	1.72	2.81	2.10	2.44	2.57	2.25
270.6	2.40	2.17	1.61	1.75	2.18	2.55	2.34	2.24

Appendix B-1. (Continued)

TOTAL PHOSPHATE-PHOSPHORUS (MG/L)

DATF	07/18/78	07/25/78	08/15/78	08/29/78	09/05/78	09/12/78	09/19/78	09/26/78
MILE POINT								
3.6	.27	.34		.31	.37	.32	.36	.23
10.3	.27	.35		.33	.41	.30	.34	.37
20.7	.39	.41		.39	.35	.31	.37	.54
30.6	.57	.43		.50	.41	.29	.43	.48
39.3	.43	.34		.48	.48	.34	.48	.57
50.0	.38	.42		.43	.37	.34	.49	.56
60.8	.29	.40		.37	.39	.37	.51	.44
70.0	.34	.40		.38	.37	.39	.44	.47
80.2	.44	.38		.39	.39	.38	.53	.52
90.2	.41	.53		.38	.29	.39	.56	.60
100.9	.44	.55		.42	.29	1.03	.45	.50
110.2	.47	.54		.49	.28	.33	.57	.53
119.9	.36	.45		.48	.30	.47	.52	.53
129.9	.42	.45		.44	.28	.61	1.04	.58
140.1	.46	.46		.44	.32	.68	.56	.51
150.2	.48	.49		.54	.34	.47	.57	.55
159.9	.50	.47	.54	.46	.41	.44	.53	.43
170.9	.44	.51	.49	.47	.41	.49	.58	.46
179.9	.43	.53	.47	.39	.46	.43	.70	.46
190.0	.41	.55	.48	.39	.41	.47	.48	.45
199.8	.49	.48	.59	.41	.48	.46	.64	.40
210.2	.37	.41	.53	.47	.45	.47	.83	.44
219.8	.39	.56	.52	.42	.43	.46	.66	.36
230.1	.44	.48	.53	.45	.48	.56	.49	.37
239.6	.34	.48	.46	.59	.50	.57	.51	.49
250.0	.39	.81	.49	.61	.46	.53	.64	.37
260.4	.41	.74	.64	.60	.45	.53	.50	.46
270.6	.43	.64	.67	.61	.56	.64	.57	.46

Appendix B-1. (Continued)

DISSOLVED ORTHO PHOSPHATE-PHOSPHORUS (MG/L)

DATE	07/18/78	07/25/78	08/15/78	08/29/78	09/05/78	09/12/78	09/19/78	09/26/78
MILE POINT								
3.6	.14	.32		.17	.20	.16	.18	.21
10.3	.16	.27		.16	.20	.15	.15	.21
20.7	.16	.29		.20	.21	.14	.17	.21
30.6	.15	.26		.21	.23	.16	.22	.23
39.3	.13	.24		.22	.21	.18	.24	.22
50.0	.13	.17		.18	.19	.18	.22	.22
60.8	.13	.20		.17	.20	.21	.21	.20
70.0	.12	.23		.17	.21	.21	.23	.21
80.2	.16	.23		.17	.20	.21	.23	.23
90.2	.14	.23		.17	.17	.23	.25	.21
100.9	.14	.23		.17	.15	.22	.25	.23
110.2	.14	.23		.17	.14	.21	.24	.24
119.9	.12	.25		.19	.15	.22	.25	.23
129.9	.16	.25		.19	.16	.39	.23	.28
140.1	.22	.22		.19	.17	.39	.22	.24
150.2	.17	.24		.26	.19	.27	.22	.22
159.9	.20	.26	.22	.47	.19	.23	.22	.21
170.9	.15	.24	.24	.28	.20	.20	.27	.21
179.9	.07	.19	.25	.21	.24	.12	.27	.21
190.0	.08	.17	.28	.19	.25	.23	.22	.21
199.8	.20	.18	.30	.25	.27	.28	.33	.23
210.2	.17	.19	.31	.25	.26	.30	.36	.22
219.8	.18	.22	.30	.22	.26	.27	.39	.22
230.1	.17	.31	.34	.24	.27	.33	.24	.21
239.6	.09	.24	.33	.38	.38	.41	.35	.33
250.0	.19	.16	.39	.33	.33	.34	.28	.27
260.4	.11	.26	.31	.34	.30	.31	.32	.27
270.6	.13	.24	.31	.33	.30	.36	.32	.27

Appendix B-1. (Continued)

SUSPENDED SOLIDS (MG/L)

DATE	07/18/78	07/25/78	08/15/78	08/29/78	09/05/78	09/12/78	09/19/78	09/26/78
MILE POINT								
3.6	64.00	56.00		52.00	38.00	30.00	55.00	69.00
10.3	44.00	64.00		68.00	91.00	26.00	61.00	87.00
20.7	126.00	146.00		91.00	44.00	34.00	93.00	195.00
30.6	300.00	113.00		139.00	66.00	39.00	89.00	112.00
39.3	177.00	55.00		132.00	116.00	46.00	129.00	207.00
50.0	138.00	123.00		108.00	71.00	47.00	163.00	161.00
60.8	104.00	91.00		66.00	70.00	50.00	219.00	87.00
70.0	115.00	90.00		71.00	66.00	52.00	75.00	100.00
80.2	109.00	71.00		57.00	29.00	43.00	130.00	104.00
90.2	202.00	198.00		84.00	15.00	64.00	173.00	173.00
100.9	221.00	167.00		72.00	19.00	66.00	84.00	145.00
110.2	199.00	159.00		152.00	19.00	68.00	134.00	153.00
119.9	144.00	101.00		90.00	30.00	78.00	121.00	116.00
129.9	129.00	107.00		66.00	19.00	71.00	198.00	100.00
140.1	139.00	91.00		64.00	23.00	16.00	129.00	83.00
150.2	113.00	82.00		54.00	35.00	62.00	131.00	98.00
159.9	130.00	100.00	58.00	56.00	36.00	43.00	126.00	82.00
170.9	147.00	102.00	54.00	62.00	63.00	71.00	125.00	90.00
179.9	178.00	98.00	46.00	34.00	46.00	43.00	210.00	83.00
190.0	182.00	110.00	44.00	138.00	37.00	35.00	110.00	82.00
199.8	72.00	72.00	50.00	22.00	55.00	36.00	181.00	38.00
210.2	117.00	72.00	45.00	38.00	37.00	27.00	177.00	47.00
219.8	76.00	100.00	44.00	20.00	32.00	43.00	110.00	45.00
230.1	58.00	64.00	52.00	46.00	39.00	34.00	91.00	37.00
239.6	55.00	40.00	22.00	28.00	11.00	17.00	40.00	29.00
250.0	58.00	104.00	27.00	44.00	22.00	25.00	64.00	22.00
260.4	49.00	96.00	42.00	24.00	22.00	34.00	59.00	38.00
270.6	56.00	61.00	62.00	40.00	31.00	34.00	37.00	30.00

Appendix B-1. (Continued)

TOTAL SOLIDS (MG/L)

DATE	07/18/78	07/25/78	OR/15/78	08/29/78	09/05/78	09/12/78	09/19/78	09/26/78
MILE POINT								
3.6	489.00	436.00		318.00	447.00	406.00	413.00	403.00
10.3	472.00	480.00		426.00	468.00	411.00	410.00	410.00
20.7	556.00	518.00		463.00	465.00	406.00	453.00	508.00
30.6	767.00	477.00		514.00	453.00	418.00	473.00	436.00
39.3	631.00	612.00		515.00	386.00	435.00	536.00	506.00
50.0	600.00	705.00		487.00	379.00	448.00	568.00	492.00
60.8	547.00	493.00		432.00	398.00	445.00	513.00	430.00
70.0	547.00	500.00		470.00	400.00	443.00	479.00	429.00
80.2	634.00	460.00		373.00	444.00	454.00	520.00	460.00
90.2	689.00	623.00		490.00	363.00	466.00	584.00	520.00
100.9	689.00	608.00		463.00	468.00	466.00	496.00	502.00
110.2	674.00	588.00		535.00	489.00	465.00	560.00	558.00
119.9	690.00	515.00		477.00	458.00	477.00	480.00	477.00
129.9	555.00	555.00		478.00	552.00	462.00	569.00	450.00
140.1	582.00	510.00		478.00	457.00	488.00	503.00	456.00
150.2	578.00	530.00		475.00	479.00	456.00	502.00	497.00
159.9	543.00	515.00	516.00	498.00	414.00	437.00	473.00	418.00
170.9	570.00	520.00	500.00	464.00	412.00	460.00	392.00	433.00
179.9	602.00	428.00	471.00	418.00	481.00	426.00	472.00	432.00
190.0	572.00	614.00	484.00	405.00	436.00	435.00	401.00	436.00
199.8	555.00	440.00	458.00	395.00	410.00	444.00	466.00	418.00
210.2	534.00	462.00	450.00	418.00	402.00	440.00	402.00	423.00
219.8	548.00	500.00	453.00	382.00	395.00	402.00	388.00	418.00
230.1	527.00	355.00	461.00	396.00	417.00	416.00	398.00	382.00
239.6	516.00	525.00	451.00	414.00	415.00	397.00	339.00	402.00
250.0	519.00	496.00	454.00	402.00	214.00	402.00	362.00	425.00
260.4	526.00	547.00	473.00	383.00	393.00	433.00	340.00	435.00
270.6	495.00	416.00	427.00	434.00	403.00	411.00	342.00	418.00

Appendix B-1. (Concluded)

ILLINOIS WATERWAY, DISCHARGE, cfs

DATE	07/18/78	07/25/78	08/29/78	09/05/78	09/12/78	09/19/78	09/26/78
MILE POINT							
3.6	27860	20620	10040	9638	3766	9517	18890
10.3	27560	20340	10090	9601	3950	9889	18450
20.7	27090	19900	10180	9544	4236	10470	17770
30.6	26600	19290	10250	9478	4497	10980	17120
39.3	26210	18920	10330	9431	4736	11460	16550
50.0	25730	18470	10420	9373	5030	12050	15850
60.8	25250	18020	10510	9314	5327	12650	15150
70.0	24830	17630	10590	9264	5580	13160	14550
80.2	24370	17200	10680	9208	5861	13730	13880
90.2	24790	16640	10800	9127	5405	17940	13960
100.9	22820	14140	9907	7503	5055	18410	12770
110.2	22580	13890	9988	7320	5170	19280	12100
119.9	22330	13640	10070	7129	5291	20200	11410
129.9	21400	12910	9964	6845	5357	20630	10590
140.1	21140	12640	10050	6644	5484	21600	9860
150.2	20350	12420	10010	6513	5776	22110	9462
159.9	19280	12460	9864	6487	6259	22180	9456
170.9	18060	12500	9699	6456	5774	21830	10740
179.9	17070	12530	9336	5840	5766	21410	10730
190.0	15960	13770	9343	5865	5758	20940	10710
199.8	15360	13930	9350	5889	5750	20480	10700
210.2	13850	12870	9325	5894	5725	18970	10440
219.8	12970	13030	9332	5918	5717	18520	10420
230.1	10600	12630	9296	5922	5691	17210	10180
239.6	9462	12790	9303	5946	5683	16760	10160
250.0	6258	9169	6553	5260	5177	10300	6474
260.4	5016	9342	6560	5286	5108	9813	6458
270.6	3502	9018	6549	5302	5093	8434	6187

Appendix B-2. Physical and Chemical Data for Illinois Waterway, 1979

ILLINOIS WATERWAY, TEMPERATURE, °C

DATE	06/0S/79	06/12/79	05/19/79	06/26/79	07/10/79	07/17/79	09/11/79	09/18/79
MILE POINT								
3.6	24.50	24.50	27.00	24.80	27.00	28.00	25.00	22.70
5.5	24.60	24.50	26.80	25.10	26.50	28.00	25.00	22.50
8.3	24.60	24.50	26.80	24.90	26.60	27.80	24.50	22.50
10.3	24.50	24.50	26.80	24.80	26.70	28.00	25.00	22.50
12.1	24.50	24.50	26.60	24.80	26.50	27.90	24.70	22.50
14.0	24.50	24.10	27.00	24.50	26.40	27.80	25.00	23.00
16.5	24.50	24.50	26.60	24.60	26.20	27.90	25.00	23.00
18.0	24.50	24.50	26.60	24.80	26.30	27.90	25.00	23.00
20.7	24.50	24.50	26.30	24.80	26.50	27.90	25.00	22.50
22.8	24.50	24.50	26.30	24.80	26.10	23.00	25.00	22.50
24.4	24.50	24.50	26.20	24.60	26.20	23.00	25.00	23.10
26.0	24.50	24.40	26.10	24.40	26.10	27.70	24.50	22.50
28.2	24.50	24.40	26.50	24.40	26.10	27.90	24.50	22.50
30.6	24.50	24.50	26.10	24.40	26.10	27.90	25.00	23.00
32.1	24.50	24.20	26.00	24.20	26.20	27.80	25.00	22.50
34.2	24.50	24.20	26.60	24.40	25.90	27.70	25.00	22.50
36.3	24.50	24.10	26.00	24.20	25.50	27.90	25.00	22.50
38.0	24.50	24.00	26.00	24.20	25.70	27.80	25.20	22.50
39.3	24.50	24.20	26.00	24.50	26.00	27.70	25.00	22.50
41.9	24.30	24.10	25.80	24.50	26.00	27.70	25.00	22.50
44.1	24.30	24.10	25.60	24.40	26.00	27.80	24.50	22.50
46.1	24.30	24.10	25.30	24.60	26.00	28.00	24.50	22.50
47.8	24.30	24.00	25.70	24.60	26.00	28.00	25.00	22.50
50.0	24.30	24.00	25.80	24.60	26.20	28.00	25.00	23.00
52.1	24.20	24.00	25.20	24.60	26.10	23.00	24.50	23.00
54.2	24.20	24.00	25.40	24.50	26.00	23.00	24.50	23.00
56.0	24.00	24.00	25.40	24.50	26.00	27.80	24.50	23.00
57.8	24.20	24.00	25.70	24.00	25.80	27.90	24.50	22.50
60.8	24.20	24.00	25.70	24.50	26.20	27.90	24.00	23.00
62.4	24.00	24.20	25.20	24.50	25.90	27.80	24.00	23.00
64.4	24.00	24.20	25.40	24.60	26.10	27.80	24.00	23.00
66.6	24.00	24.20	25.40	24.50	25.60	27.70	24.00	22.80
68.4	24.00	24.00	25.50	24.50	26.10	27.70	24.00	23.00
70.0	24.00	24.00	25.60	24.60	26.50	27.90	24.50	24.00
71.7	24.00	24.00	25.40	24.60	26.10	27.30	24.00	22.50
74.5	24.00	24.00	25.20	24.70	25.90	27.70	24.00	23.00
75.9	24.00	24.00	25.20	24.50	26.00	27.60	24.00	22.50
78.4	24.20	24.00	25.30	24.40	26.00	27.50	24.00	23.00
80.2	24.40	25.00	25.10	24.70	26.50	27.50	24.50	23.50
82.3	24.30	24.60	24.90	24.50	25.00	27.50	24.00	23.00
84.1	24.50	24.50	25.10	25.90	25.70	27.50	23.50	23.00
86.0	24.50	24.50	24.80	24.00	25.80	27.30	23.50	23.50
87.9	24.10	24.60	25.00	24.50	26.50	26.50	23.50	23.00
90.2	24.90	23.60	25.50	23.50	25.90	26.40	25.00	21.00
91.5	25.20	24.20	25.60	23.00	26.00	26.00	25.20	20.50
94.3	24.80	23.80	25.50	23.20	25.30	25.80	25.20	20.50
95.8	24.90	23.30	25.50	23.10	25.90	25.80	25.20	20.50
98.2	25.00	23.00	25.50	23.00	25.70	25.40	25.00	20.30
100.9	24.60	23.10	25.50	23.20	26.00	26.00	25.00	20.30
102.8	24.80	23.20	25.50	23.10	25.70	25.80	24.80	20.30
104.0	24.80	23.00	25.50	23.10	25.70	25.50	24.80	20.20
105.5	24.80	22.80	25.50	23.10	25.70	25.50	24.80	20.20
108.2	24.70	22.90	25.50	23.10	25.60	25.90	25.00	20.20
110.2	24.50	23.00	25.30	23.30	26.00	26.10	25.00	20.20
111.8	24.50	22.70	25.30	23.20	25.00	26.10	25.10	20.00
114.3	24.50	22.80	25.30	23.30	25.70	26.00	25.30	19.30
116.3	24.10	22.50	25.10	23.10	25.50	25.70	25.00	20.00
118.0	24.20	22.50	25.10	23.20	25.50	25.50	25.00	20.00
119.9	24.20	22.50	25.50	23.10	25.50	26.00	25.00	20.20
121.8	24.80	22.50	25.10	23.00	26.00	26.20	25.00	20.20
123.6	24.60	22.60	25.00	23.00	25.50	26.20	25.00	20.20
125.8	24.60	23.00	2S.10	23.00	2S.50	26.00	25.00	20.00
128.1	24.40	23.00	25.00	23.00	26.50	26.00	24.50	20.40
129.9	24.50	23.00	24.90	23.00	26.00	26.10	24.50	20.50
132.0	24.50	23.00	25.00	23.00	25.50	25.80	24.50	20.30
134.0	24.20	22.50	25.00	23.00	26.00	25.60	24.50	20.50
135.7	24.30	22.50	25.00	23.10	26.50	25.30	25.00	20.50
137.5	24.30	22.50	25.00	23.20	26.00	25.30	25.00	20.50
140.1	24.50	22.80	25.00	23.20	26.00	25.60	24.50	20.50
143.2	24.20	23.00	25.00	23.10	26.00	25.30	24.00	21.50
145.5	24.00	22.80	25.00	23.10	25.50	25.10	24.00	21.20
147.3	24.50	23.00	25.00	23.10	26.00	25.20	24.00	21.00
148.2	24.50	23.00	25.00	23.10	26.00	25.30	24.00	21.00
150.2	24.80	23.10	25.00	23.50	27.00	26.00	24.00	21.00
152.2	24.40	23.10	25.00	25.30	25.00	25.80	24.00	21.50
154.2	24.60	23.20	24.50	23.00	26.50	25.50	24.00	23.00
156.5	24.00	22.90	24.50	23.10	27.00	24.70	23.50	21.00
158.0	23.80	23.10	24.10	23.20	26.00	25.20	23.50	21.80
159.9	23.00	23.20	24.20	23.30	26.50	25.20	24.00	21.80
162.0	23.00	23.50	24.20	23.40	26.50	25.10	24.00	21.50

Appendix B-2. (Continued)

ILLINOIS WATERWAY, TEMPERATURE, °C

DATE	05/05X79	06/12/79	05/19/79	OS/26/79	07/10/79	07/17/79	09/11/79	09/18/79
MILE POINT								
163.9	24.00		24.00	23.40	26.50	25.00	24.00	22.00
166.1	28.40	23.20	24.00	23.00	27.50	24.50	26.00	21.00
167.9	29.40	23.20	24.00	24.00	28.50	24.90	26.00	20.00
170.9	24.00	23.20	24.00	23.20	26.50	24.30	25.50	20.00
173.2	24.70	23.00	23.80	23.30	28.00	25.10	25.70	20.00
174.9	25.00	23.00	24.00	23.50	27.50	25.20	26.00	20.00
175.6	24.20	23.00	23.50	23.90	25.00	25.60	26.00	20.00
179.0	24.50	23.00	24.00	24.00	26.00	25.40	26.00	20.00
179.9	24.80	23.20	24.10	24.00	25.80	25.80	26.00	20.50
181.9	24.30	23.20	24.00	23.50	26.00	24.50	27.50	20.50
184.1	24.50	23.50	23.50	24.30	26.50	26.00	28.50	21.00
186.4	24.30	23.50	24.00	24.80	29.00	26.10	23.50	20.50
187.9	25.00	23.20	23.50	24.50	27.00	26.20	27.00	20.50
190.0	23.80	23.20	23.50	24.00	26.80	26.20	27.00	21.00
191.6	23.90	23.20	24.00	25.00	27.00	26.20	27.00	21.00
194.1	23.80	23.20	23.20	24.50	26.00	25.80	27.00	21.00
196.0	24.00	23.20	23.60	24.20	26.50	26.00	27.00	21.00
193.1	24.40	23.20	24.20	24.50	23.50	26.20	26.00	21.00
199.8	24.10	23.20	24.10	24.00	25.20	26.40	26.00	21.50
202.5	23.60	23.20	23.50	25.00	25.00	26.40	26.00	21.50
204.0	23.70	23.20	23.50	25.00	25.00	26.20	25.50	22.00
206.0	23.50	23.00	23.20	25.00	25.00	26.00	25.50	21.50
208.0	23.50	23.00	23.20	24.00	25.00	25.80	24.50	21.50
210.2	23.90	23.00	24.20	24.50	26.20	26.20	24.50	22.00
212.0	23.60	22.80	23.80	24.00	24.50	26.00		22.00
213.8	23.80	22.50	23.60	24.50	24.50	26.10	24.20	21.50
215.7	23.80	22.90	23.20	24.00	24.50	26.00	24.50	21.50
218.4	24.10	23.00	23.80	24.50	25.00	26.80	24.50	22.00
219.8	23.50	22.80	23.20	24.00	24.50	26.40	24.50	22.00
222.0	23.50	22.90	23.00	24.20	25.00	26.60	24.50	22.00
223.9	23.20	22.80	23.00	24.00	25.00	26.70	25.00	22.00
225.8	23.20	22.60	23.20	23.50	25.00	26.30	25.00	21.50
228.0	23.80	22.60	23.20	23.60	25.00	26.00	24.50	21.50
230.1	24.20	22.80	23.50	23.50	25.00	26.40	24.50	21.50
231.7	24.80	23.00	23.00	24.20	26.00	27.50	25.00	23.00
234.2	24.00	23.00	23.00	25.00	25.00	23.00	25.00	23.00
236.2	24.50	22.90	23.00	24.50	24.00	27.20	25.00	22.00
237.9	24.80	23.00	23.20	24.00	25.00	26.30	25.00	22.00
239.6	25.00	22.80	23.40	24.00	24.20	26.40	24.50	22.00
242.0	25.00	23.00	23.50	24.50	25.50	26.60	24.50	23.00
244.0	25.00	24.00	23.80	25.00	26.50	26.50	24.50	23.00
247.8	25.00	24.00	23.50	25.00	25.00	26.40	24.00	23.00
250.0	25.00	24.00	23.50	25.00	24.40	26.50	23.70	23.00
251.8	25.50	24.00	23.20	25.20	25.00	26.00	23.70	23.00
254.0	25.80	24.00	23.00	25.10	24.50	26.00	24.00	23.00
2S6.0	26.00	24.00	22.80	24.90	24.00	26.00	24.00	23.00
258.0	26.00	24.00	22.80	25.00	24.00	26.00	23.30	23.00
260.4	25.00	24.00	23.20	25.40	24.00	26.20	23.50	23.00
262.3	25.50	23.80	22.40	25.60	25.00	26.10	23.50	23.00
264.0	25.50	23.80	22.20	25.50	25.00	26.00	23.50	23.00
265.8	2S.50	23.80	22.40	25.80	25.00	26.50	23.00	23.00
268.9	26.00	23.80	22.20	26.00	25.00	26.70	23.50	23.00
270.6	26.00	24.00	22.40	26.20	25.10	27.00	24.00	23.00

Appendix B-2. (Continued)

ILLINOIS WATERWAY, TEMPERATURE, °C

DATE	06/05/79	06/12/79	06/19/79	06/26/79	07/10/79	07/17/79	09/11/79	09/18/79
MILE POINT								
3.6	24.50	24.50	27.00	24.80	27.00	28.00	25.00	22.70
10.3	24.50	24.50	26.80	24.80	26.70	28.00	.25.00	22.50
20.7	24.50	24.50	26.30	24.80	26.50	27.90	25.00	22.50
30.6	24.50	24.50	26.10	24.40	26.10	27.90	25.00	23.00
39.3	24.50	24.20	26.00	24.50	26.00	27.70	25.00	22.50
50.0	24.30	24.00	25.80	24.60	26.20	23.00	25.00	23.00
60.8	24.20	24.00	25.70	24.50	26.20	27.90	24.00	23.00
70.0	24.00	24.00	25.60	24.60	26.50	27.90	24.50	24.00
80.2	24.40	25.00	25.10	24.70	26.50	27.50	24.50	23.50
90.2	24.90	23.60	25.50	23.50	25.90	26.40	25.00	21.00
100.9	24.60	23.10	25.50	23.20	26.00	26.00	25.00 '	20.30
110.2	24.50	23.00	25.30	23.30	26.00	26.10	25.00	20.20
119.9	24.20	22.50	25.50	23.10	25.50	26.00	25.00	20.20
129.9	24.50	23.00	24.90	23.00	26.00	26.10	24.50	20.50
140.1	24.50	22.80	25.00	23.20	26.00	25.60	24.50	20.50
150.2	24.80	23.10	25.00	23.50	27.00	26.00	24.00	21.00
159.9	23.00	23.20	24.20	23.30	26.50	25.20	24.00	21.80
170.9	24.00	23.20	24.00	23.20	26.50	24.30	25.50	20.00
179.9	24.80	23.20	24.10	24.00	25.30	25.80	26.00	20.50
190.0	23.80	23.20	23.50	24.00	26.80	26.20	27.00	21.00
199.8	24.10	23.20	24.10	24.00	25.20	26.40	26.00	21.50
210.2	23.90	23.00	24.20	24.50	26.20	26.20	24.50	22.00
219.8	23.50	22.30	23.20	24.00	24.50	26.40	24.50	22.00
230.1	24.20	22.80	23.50	23.50	25.00	26.40	24.50	21.50
239.6	25.00	22.80	23.40	24.00	24.20	26.40	24.50	22.00
250.0	25.00	24.00	23.50	25.00	24.40	26.50	23.70	23.00
260.4	25.00	24.00	23.20	25.40	24.00	26.20	23.50	23.00
270.6	26.00	24.00	22.40	26.20	25.10	27.00	24.00	23.00

ILLINOIS WATERWAY, TURBIDITY, NTU

DATE	06/05/79	06/12/79	06/19/79	06/26/79	07/10/79	07/17/79	09/11/79	09/18/7
MILE POINT								
3.6	28.70	57.30	34.00	27.00	20.20	18.50	19.90	22.70
10.3	29.80	83.20	32.10	25.90	23.70	26.20	21.50	24.10
20.7	37.20	57.00	50.30	28.40	24.40	19.80	27.40	23.30
30.6	51.10	80.70	47.10	42.70	21.10	22.10	24.60	24.60
39.3	61.10	110.10	58.20	48.90	23.90	25.70	27.60	35.00
50.0	56.90	114.20	49.80	48.30	25.60	28.40	28.20	42.80
60.8	41.90	84.30	46.60	36.00	18.20	22.90	29.90	38.30
70.0	50.80	98.70	54.60	35.40	21.10	36.90	37.00	23.80
80.2	46.00	43.30	41.70	23.90	19.40	23.40	34.30	26.10
90.2	62.10	169.40	54.70	49.20	34.40	49.30	33.70	40.40
100.9	51.30	152.50	37.70	32.70	24.50	30.70	28.80	39.30
110.2	66.20	135.50	49.00	36.40	33.30	39.10	37.90	49.60
119.9	55.80	44.20	35.60	35.10	33.70	33.70	41.70	
129.9	42.80	52.90	46.60	25.40	24.70	28.80	32.30	35.50
140.1	38.50	53.80	46.70	26.60	19.80	36.20	44.80	52.30
150.2	45.90	52.20	38.60	23.30	26.80	33.70	37.80	34.90
159.9	43.60	52.30	51.90	36.90	24.10	30.60	28.10	32.90
170.9	50.70	55.20	49.60	29.30	39.10	29.30	31.00	41.30
179.9	48.80	41.40.	57.30	33.10	32.70	33.10	34.90	37.10
190.0	62.70	39.40	46.70	20.50	28.40	37.60	26.60	29.60
199.8	58.60	28.10	30.90	19.60	36.20	30.80	25.20	14.80
210.2	23.40	20.00	22.90	9.60	30.30	30.10	23.80	13.30
219.8	29.20	24.80	27.50	17.30	39.30	22.90	19.10	13.20
230.1	20.30	27.40	24.70	13.30	45.90	25.10	20.70	20.40
239.6	13.20	27.20	19.50	11.80	50.80	18.90	3.71	7.60
250.0	21.20	27.10	15.60	10.90	42.30	14.30	11.30	9.60
260.4	16.90	25.30	22.40	17.20	34.80	17.90		13.30
270.6	21.00	25.70	26.90	14.60	28.80	18.60	15.40	15.80

Appendix B-2. (Continued)

ILLINOIS WATERWAY, CHLORIDE, mg/l

DATE	06/05/79	06/12/79	06/19/79	06/26/79	07/10/70	07/17/79	09/11/79	09<18/79
MILE POINT								
3.6	40.00	39.50	51.40	45.40	51.40	52.40	33.50	40.20
10.3	39.00	42.00	56.90	45.90	50.40	50.40	39.30	38.80
20.7	39.50	40.50	55.40	44.60	54.80	48.50	40.30	40.70
30.6	39.00	44.50	52.40	44.40	54.50	47.00	41.70	42.70
39.3	38.50	45.00	51.40	45.40	52.90	44.20	42.20	39.80
50.0	39.50	46.50	50.40	44.90	54.80	42.70	43.20	43.20
60.8	40.50	41.00	51.40	44.90	54.80	43.20	44.60	43.20
70.0	42.50	52.50	50.40	45.90	53.80	39.80	41.20	42.70
80.2	41.00	47.00	50.90	43.90	53.40	41.20	41.70	43.70
90.2	45.00	51.50	52.40	44.90	57.20	40.80	42.70	48.00
100.9	46.00	53.50	53.90	45.40	53.80	40.30	43.70	48.00
110.2	47.50	55.00	49.40	43.90	52.90	39.80	45.60	48.00
119.9	49.50	63.00	38.40	47.90	44.60	42.70	45.10	
129.9	53.00	57.90	55.40	51.80	53.40	40.70	48.00	51.90
140.1	55.50	69.00	50.40	52.30	51.90	44.10	51.40	48.50
150.2	59.50	69.50	51.90	51.80	50.40	47.50	50.00	48.50
159.9	54.50	68.00	49.90	47.90	48.00	48.00	47.50	49.50
170.9	58.00	62.40	45.50	49.90	46.10	46.10	48.50	50.00
179.9	64.00	56.00	46.30	52.30	38.80	45.10	51.90	51.90
190.0	63.50	54.00	49.50	52.80	41.70	49.00	50.40	57.20
199.8	65.00	51.50	52.00	54.80	40.30	50.00	51.40	61.10
210.2	71.00	48.50	50.50	57.30	39.30	50.00	50.40	61.10
219.8	51.00	53.50	53.50	55.80	38.80	52.40	48.00	65.00
230.1	70.00	52.00	54.00	55.80	34.40	50.90	46.60	62.60
239.6	77.00	68.50	57.50	63.30	41.20	49.70	52.40	71.80
250.0	75.00	52.50	60.00	60.80	40.70	47.50	61.60	73.20
260.4	78.50	65.50	61.50	64.30	48.50	49.00		64.00
270.6	93.50	62.00	44.00	68.80	59.20	49.50	57.20	60.10

ILLINOIS WATERWAY, DISSOLVED OXYGEN, mg/l

DATE	06/05/79	06/12/79	06/19/79	06/26/79	07/10/79	07/17/79	09/11/79	09/18/79
MILE POINT								
3.6	4.60	3.40	5.70	5.10	6.20	7.00	6.20	7.30
10.3	5.10	3.50	5.80	5.30	5.40	5.70	5.70	7.30
20.7	4.80	3.80	5.70	4.70	5.10	5.50	5.60	7.10
30.6	4.70	4.30	5.60	5.30	4.70	5.80	5.60	7.00
39.3	4.90	4.40	5.30	5.60	5.10	5.90	5.40	7.00
50.0	5.00	4.40	5.60	5.80	4.60	5.90	5.90	6.80
60.8	4.90	5.00	6.00	6.20	4.80	5.60	5.70	7.00
70.0	5.00	5.10	6.10	6.40	5.20	5.60	5.80	7.10
80.2	4.60	4.80	5.50	6.40	4.70	4.90	4.60	6.40
90.2	4.70	4.20	5.30	6.30	5.00	5.50	5.60	5.80
100.9	4.70	4.30	5.20	6.60	5.00	5.30	5.80	6.00
110.2	4.60	4.50	5.10	7.20	5.10	5.50	5.60	6.30
119.9	4.40	5.00	6.40	7.10	5.40	6.00	5.50	7.00
129.9	4.80	5.10	5.40	6.70	5.70	6.40	6.60	7.00
140.1	5.20	4.90	5.30	5.20	6.20	6.30	6.50	6.50
150.2	5.50	5.00	5.80	7.10	6.80	6.90	7.50	7.00
159.9	5.70	4.60	6.00	7.10	7.10	7.60	8.20	8.20
170.9	5.40	4.90	5.50	5.30	5.30	6.10	10.30	8.10
179.9	4.40	4.50	4.60	4.30	6.30	3.80	7.00	7.20
190.0	5.10	5.00	5.30	4.10	6.90	4.40	7.70	7.30
199.8	6.70	5.70	5.80	4.80	6.00	5.70	8.70	7.00
210.2	7.80	6.50	7.20	5.30	7.20	6.80	7.90	7.70
219.8	6.60	6.70	6.90	6.70	7.30	6.60	S.40	8.00
230.1	7.60	7.20	6.40	8.20	7.30	7.50	8.70	
239.6	S.SO	5.50	6.00	6.00	6.30	6.50	6.70	6.60
250.0	4.70	5.30	5.70	6.70	6.30	7.60	6.50	7.00
260.4	5.65	6.40	6.20	6.80	7.30	7.40	6.50	7.00
270.6	6.40	6.60	7.80	7.80	7.70	7.80	3.00	7.00

Appendix B-2. (Continued)

ILLINOIS WATERWAY, pH

OATE	05/05/79	06/12/79	06/19/79	06/26/79	07/10/79	07/17/79	09/11/79	09/18/79
MILE POINT								
3.6	8.18	8.38	8.17	8.10	8.31	8.60	8.04	8.46
10.3	8.16	8.45	8.18	8.31	8.25	8.48	8.04	8.39
20.7	8.13	8.52	8.12	8.22	8.22	8.35	8.02	8.35
30.6	8.13	8.51	8.12	8.10	8.08	8.32	8.03	8.37
39.3	8.14	8.40	8.08	8.35	8.13	8.26	7.98	8.36
50.0	8.18	8.47	8.15	8.48	8.25	8.24	8.07	8.30
60.8	8.20	8.41	8.09	8.19	8.05	8.25	8.03	3.30
70.0	8.27	8.33	8.15	8.18	8.08	8.27	8.09	8.36
80.2	8.22	8.17	8.21	8.34	8.00	8.29	9.11	8.29
90.2	8.18	8.05	8.08	8.24	8.48	8.21	8.04	8.31
100.9	8.39	8.02	8.37	8.27	8.48	8.11	8.10	8.31
110.2	8.32	8.05	8.36	8.38	8.41	8.13	3.02	8.29
119.9	8.40	8.16	8.36	8.27	8.53	8.23	8.00	8.35
129.9	8.53	8.08	8.39	8.18	8.63	8.21	8.13	8.35
140.1	8.31	8.06	8.21	8.23	3.60	8.15	8.14	8.19
150.2	8.33	8.01	8.22	8.17	8.82	8.33	8.39	8.16
159.9	8.36	8.00	8.37	8.23	3.81	8.23	8.61	8.36
170.9	8.09	8.10	7.99	8.12	7.96	8.59	8.67	8.65
179.9	8.05	7.92	7.87	7.89	7.97	8.30	8.31	3.37
190.0	8.10	7.88	7.96	7.84	7.97	8.02	8.35	3.31
199.8	8.32	7.98	8.01	7.78	7.85	8.18	8.46	8.13
210.2	8.40	8.00	8.19	7.76	7.95	8.02	8.37	8.17
219.8	8.43	7.94	8.11	7.86	7.89	8.21	8.46	8.30
230.1	8.49	7.93	8.15	7.94	8.02	8.29	8.46	8.25
239.6	8.05	7.67	7.99	7.76	7.81	8.19	3.21	7.84
250.0	8.20	7.69	8.00	7.90	7.80	8.06	8.21	7.86
260.4	8.11	7.77	7.95	7.81	7.90	8.08		7.32
270.6	8.27	7.81	8.10	8.02	7.92	8.08	8.19	7.88

ILLINOIS WATERWAY, ALKALINITY, mg/l

OATE	06/05/79	06/12/79	06/19/79	06/26/79	07/10/79	07/17/79	09/11/79	09/18/79
MILE POINT								
3.6	203.00	197.00	192.80	193.60	182.00	181.00	186.00	202.00
10.3	204.00	202.00	194.50	191.60	181.00	178.00	190.00	198.00
20.7	205.00	202.00	195.70	186.70	179.00	176.00	190.00	198.00
30.6	204.00	210.00	194.50	187.50	178.00	173.00	196.00	201.00
39.3	206.00	212.00	196.10	186.20	130.00	173.00	198.00	202.00
50.0	206.00	210.00	194.10	188.70	178.00	173.00	195.00	202.00
60.8	206.00	209.00	197.30	189.10	181.00	172.00	193.00	202.00
70.0	210.00	210.00	196.90	187.50	181.00	169.00	193.00	202.00
80.2	210.00	202.00	195.70	193.20	173.00	165.00	197.00	202.00
90.2	205.00	194.00	192.80	192.80	177.00	165.00	201.00	207.00
100.9	206.00	190.00	192.80	193.60	176.00	164.00	195.00	203.00
110.2	210.00	190.00	192.80	196.10	177.00	165.00	199.00	203.00
119.9	207.00	192.00	208.10	191.60	174.00	164.00	199.00	203.00
129.9	210.00	193.00	189.50	196.90	169.00	161.00	203.00	206.00
140.1	211.00	190.00	188.70	193.60	167.00	161.00	204.00	202.00
150.2	211.00	186.00	185.40	192.80	165.00	161.00	199.00	198.00
159.9	185.00	181.00	183.80	192.80	152.00	205.00	200.00	201.00
170.9	208.00	185.80	175.90	187.50	166.00	169.00	193.00	195.00
179.9	205.00	186.20	176.30	185.40	164.00	157.00	197.00	185.00
190.0	203.00	186.20	183.30	184.90	160.00	152.00	197.00	179.00
199.8	198.00	182.10	182.10	178.40	157.00	157.00	194.00	178.00
210.2	197.00	181.30	185.40	176.30	158.00	194.00	192.00	173.00
219.8	192.00	179.20	184.90	176.30	152.00	193.00	188.00	171.00
230.1	192.00	179.20	181.30	175.90	153.00	153.00	188.00	167.00
239.6	186.00	160.70	176.30	173.00	142.00	200.00	179.00	165.00
250.0	187.00	157.40	176.70	176.30	148.00	165.00	173.00	171.00
260.4	199.00	166.90	168.10	172.30	194.00	161.00		163.00
270.6	197.00	168.90	180.90	173.00	157.00	157.00	176.00	165.00

Appendix B-2. (Continued)

ILLINOIS WATERWAY, HARDNESS, mg/l

DATE	06/05/79	06/12/79	06/19/79	06/26/79	07/10/79	07/17/79	09/11/79	09/18/79
MILE POINT								
3.6	296.00	301.30	306.70	297.30	287.00	273.00	279.00	293.00
10.3	306.70	312.00	112.00	294.00	287.00	277.00	293.00	297.00
20.7	315.30	312.70	310.00	287.30	274.00	274.00	287.00	297.00
30.6	307.30	321.30	306.70	286.70	280.00	275.00	287.00	299.00
39.3	313.30	326.70	307.30	288.70	280.00	273.00	287.00	303.00
50.0	300.70	330.00	306.70	290.00	280.00	270.00	287.00	305.00
60.6	315.00	325.30	312.00	293.30	286.00	273.00	287.00	306.00
70.0	320.00	326.70	307.30	293.30	283.00	270.00	300.00	308.00
80.2	326.00	325.30	307.30	294.00	287.00	265.00	298.00	307.00
90.2	326.70	316.70	306.70	301.30	282.00	261.00	297.00	313.00
100.9	314.00	313.30	306.00	304.70	280.00	237.00'	300.00	310.00
110.2	331.30	319.30	306.70	306.70	281.00	267.00	300.00	317.00
119.9	333.30	320.00	325.30	300.00	275.00	260.00	303.00	
129.9	326.70	319.30	300.00	305.30	270.00	257.00	307.00	317.00
140.1	341.30	314.70	298.00	300.70	272.00	259.00	307.00	317.00
150.2	343.30	310.00	293.30	301.30	265.00	260.00	311.00	313.00
159.9	303.30	306.70	292.00	300.00	247.00	257.00	293.00	310.00
170.9	330.00	300.00	280.00	300.00	270.00	267.00	287.00	307.00
179.9	333.00	298.70	273.30	295.30	270.00	252.00	293.00	297.00
190.0	332.00	299.30	285.30	296.70	233.00	247.00	293.00	288.00
199.8	327.00	293.30	286.70	286.70	252.00	253.00	293.00	290.00
210.2	321.00	285.30	288.00	286.00	253.00	243.00	293.00	282.00
219.8	319.00	292.00	236.00	280.70	243.00	247.00	290.00	232.00
230.1	307.00	235.30	285.30	280.00	243.00	245.00	277.00	280.00
239.6	323.00	266.70	280.70	280.00	233.00	253.00	277.00	273.00
250.0	325.00	258.70	274.70	273.30	233.00	257.00	278.00	268.00
260.4	315.00	263.30	261.30	273.30	220.00	250.00		260.00
270.6	313.00	260.00	286.70	260.00	243.00	240.00	273.00	243.00

Appendix B-2. (Continued)

ILLINOIS WATERWAY, AMMONIA-NITROGEN, mg/l

MILE POINT	DATE 06/05/79	06/12/79	06/19/79	06/26/79	07/10/79	07/17/79	09/11/79	09/18/79
3.6	.07	0.00	.05	0.00	.01	0.00	.03	.03
10.3	.04	.02	.04	0.00	0.00	0.00	.03	.03
20.7	.01	.04	.07	0.00	.05	0.00	.06	.05
30.6	.04	.04	.09	.01	0.00	0.00	.20	.03
39.3	.01	0.00	.03	.01	.02	.03	.11	.07
50.0	.15	0.00	.03	0.00	0.00	.10	.16	.03
60.8	.09	.06	.02	0.00	0.00	0.00	.05	.05
70.0	.14	.06	.01	0.00	.02	0.00	.05	.04
80.2	.02	.08	.01	0.00	.02	0.00	.04	.06
90.2	.04	.09	.01	0.00	.02	.07	.01	.15
100.9	.06	.13	.01	.01	.01	.09	.06	.17
110.2	.12	.16	.01	.02	.02	.15	.07	.21
119.9	.02	.22	.07	.02	.01	.11	.10	.15
129.9	.05	.23	.03	.07	.10	.16	.03	.24
140.1	.01	.31	.05	.04	.01	.10	.06	.20
150.2	.06	.49	.04	.06	.01	.12	.03	.16
159.9	.01	.55	.03	.07	.02	.06	.09	.33
170.9	.40	.60	.33	.26	.11	0.00	.14	.07
179.9	.50	.69	.44	.19	.17	.04	.22	.05
190.0	.33	.48	.40	.27	.23	.17	.08	.24
199.8	.35	.44	.48	.50	.30	.04	.09	.66
210.2	.80	.53	.43	.05	.51	.05	.13	.54
219.8	.42	.87	.72	.45	.54	.03	.36	.87
230.1	.78	1.10	.89	.60	.56	.23	.26	.93
239.6	1.46	2.01	.90	1.17	.89	.26	.71	1.97
250.0	1.55	1.71	1.52	1.46	1.15	.67	.92	3.16
260.4	1.31	2.68	1.47	1.83	1.06	.71	1.45	2.58
270.6	2.42	2.79	1.01	2.71	1.95	.97	1.68	2.41

ILLINOIS WATERWAY, N03-N, mg/l

MILE POINT	DATE 06/05/79	06/12/79	06/19/79	06/26/79	07/10/79	07/17/79	09/11/79	09/18/79
3.6	4.05	3.72	4.86	4.62	3.33	3.10	2.21	2.02
10.3	3.92	4.07	4.74	4.79	2.94	3.12	2.06	1.92
20.7	3.86	3.79	4.82	4.59	3.43	2.78	2.13	1.87
30.6	3.92	4.33	4.72	4.47	3.51	2.98	2.06	1.97
39.3	4.01	3.96	4.88	4.26	3.18	3.05	2.06	2.14
50.0	4.57	4.07	4.68	4.41	3.24	3.12	2.08	1.90
60.8	3.80	4.22	4.37	4.35	3.34	3.20	1.96	2.02
70.0	3.80	4.27	4.51	4.26	3.00	3.35	1.96	1.84
80.2	3.88	4.61	4.74	4.13	3.16	3.42	1.96	1.96
90.2	4.03	4.42	4.70	4.40	3.43	3.98	2.11	1.93
100.9	3.71	4.46	4.72	4.43	3.33	4.12	2.01	2.02
110.2	4.16	4.59	4.12	4.43	3.01	4.37	2.10	2.07
119.9	4.16	4.35	5.35	4.19	2.82	4.28	2.00	2.07
129.9	3.80	4.33	4.51	4.43	3.20	4.18	2.21	2.09
140.1	3.97	4.40	4.44	4.41	2.82	4.27	2.36	2.30
150.2	4.22	4.14	4.01	4.57	2.47	4.17	2.13	2.35
159.9	4.03	4.11	4.21	4.25	2.43	4.27	2.05	2.09
170.9	3.74	4.36	4.53	4.24	3.38	4.32	2.34	2.40
179.9	3.63	4.27	4.51	4.38	3.77	4.30	2.52	2.72
190.0	3.53	4.29	4.43	4.16	4.37	4.40	2.51	2.82
199.8	3.38	4.07	4.48	3.73	4.90	4.33	2.54	2.79
210.2	3.58	4.70	4.22	3.63	4.85	4.05	2.74	2.92
219.3	3.31	4.46	4.39	3.48	4.98	3.70	2.69	3.15
230.1	3.12	4.03	4.22	3.17	4.85	3.47	2.69	2.94
239.6	3.47	3.58	4.39	3.56	5.30	3.48	3.25	3.04
250.0	3.33	3.69	3.58	3.03	4.85	3.12	2.85	2.41
260.4	3.12	2.91	3.06	2.69	4.86	3.22	2.59	2.26
270.6	2.89	2.91	3.59	2.18	4.17	2.90	2.42	2.09

Appendix B-2. (Continued)

ILLINOIS WATERWAY, DISSOLVED ORTHO PHOSPHATE, mg/l

DATE	06/05/79	06/12/79	06/19/79	06/26/79	07/10/79	07/17/79	09/11/79	09/18/79
MILE POINT								
3.6	.11	.10	.2*	.33	.11	.16	.13	.13
10.3	.12	.15	.23	.30	.17	.15	.17	.19
20.7	.08	.15	.30	.31	.18	.14	.16	.17
30.6	.11	.16	.32	.42	.11	.14	.12	.17
39.3	.07	.15	.30	.29	.15	.13	.16	.26
50.0	.11	.14	.20	.31	.13	.15	.16	.21
60.8	.11	.18	.20	.33	.11	.12	.13	.26
70.0	.08	.19	.18	.22	.15	.12	.10	.16
80.2	.01	.03	.23	.23	.20	.12	.17	.21
90.2	.07	.13	.19	.36	.14	.14	.17	.22
100.9	.03	.27	.30	.35	.15	.17	.10	.27
110.2	.12	.21	.13	.26	.23	.18	.10	.30
119.9	.11	.21	.12	.28	.19	.14	.16	.24
129.9	.07	.23	.27	.31	.19	.18	.18	.21
140.1	.06	.22	.24	.36	.11	.17	.20	.34
150.2	.01	.22	.15	.34	.14	.21	.18	.28
159.9	.08	.21	.16	.28	.07	.15	.16	.23
170.9	.16	.24	.16	.24	.25	.15	.20	.19
179.9	.18	.22	.30	.21	.17	.18	.24	.25
190.0	.15	.31	.17	.23	.17	.19	.23	.25
199.8	.13	.24	.26	.25	.18	.19	.21	.23
210.2	.11	.25	.22	.25	.21	.15	.27	.27
219.8	.12	.28	.24	.26	.19	.17	.24	.26
230.1	.11	.27	.23	.20	.18	.17	.20	.27
239.6	.32	.38	.32	.37	.23	.17	.30	.39
250.0	.30	.28	.28	.25	.24	.18	.30	.43
260.4	.31	.37	.30	.28	.21	.12	.36	.33
270.6	.32	.42	.14	.35	.20	.15	.26	.29

ILLINOIS WATERWAY, TOTAL PHOSPHATE, mg/l

DATE	06/05/79	06/12/79	06/19/79	06/26/79	07/10/79	07/17/79	09/11/79	09/18/79
MILE POINT								
3.6	.29	.28	.40	.39	.34	.28	.30	.29
10.3	.29	.54	.38	.39	.32	.31	.31	.29
20.7	.30	.45	.47	.48	.33	.28	.33	.32
30.6	.37	.44	.49	.50	.33	.28	.32	.33
39.3	.44	.41	.53	.61	.34	.32	.33	.38
50.0	.43	.45	.45	.53	.35	.31	.38	.42
60.8	.35	.58	.44	.47	.33	.29	.37	.42
70.0	.39	.42	.60	.49	.34	.38	.39	.32
80.2	.37	.34	.49	.44	.38	.31	.41	.33
90.2	.49	.68	.55	.56	.43	.46	.41	.44
100.9	.40	.64	.49	.44	.42	.33	.41	.43
110.2	.56	.63	.58	.52	.48	.34	.48	.49
119.9	.52	.44	.40	.51	.51	.37	.51	
129.9	.44	.54	.40	.44	.41	.35	.45	.43
140.1	.46	.57	.58	.49	.38	.38	.54	.65
150.2	.52	.47	.45	.48	.40	.37	.51	.45
159.9	.44	.49	.50	.53	.35	.37	.42	.43
170.9	.42	.63	.46	.38	.45	.34	.44	.55
179.9	.50	.48	.50	.39	.37	.36	.54	.55
190.0	.68	.52	.50	.36	.34	.50	.48	.50
199.8	.60	.45	.32	.36	.40	.44	.45	.42
210.2	.41	.42	.41	.40	.37	.45	.47	.48
219.8	.47	.52	.44	.37	.43	.41	.45	.45
230.1	.43	.49	.45	.37	.44	.39	.44	.49
239.6	.49	.62	.44	.43	.47	.43	.47	.56
250.0	.58	.47	.48	.38	.45	.26	.46	.63
260.4	.55	.65	.49	.52	.45	.38		.55
270.6	.66	.58	.39	.51	.45	.37	.54	.56

Appendix B-2. (Continued)

ILLINOIS WATERWAY, SUSPENDED SOLIDS, mg/l

BATE	06/05/79	06/12/79	06/19/79	06/26/79	07/10/79	07/17/79	09/11/79	09/18/79
MILE POINT								
3.6	86.00	154.00	84.00	70.00	60.00	40.00	28.00	54.00
10.3	72.00	184.00	90.00	60.00	54.00	66.00	32.00	50.00
20.7	88.00	168.00	156.00	64.00	82.00	44.00	56.00	59.00
30.6	130.00	230.00	150.00	108.00	62.00	54.00	34.00	54.00
39.3	198.00	334.00	242.00	156.00	74.00	72.00	54.00	102.00
50.0	218.00	404.00	152.00	180.00	70.00	72.00	54.00	152.00
60.8	106.00	276.00	156.00	110.00	50.00	46.00	56.00	120.00
70.0	140.00	330.00	184.00	102.00	58.00	96.00	96.00	52.00
80.2	118.00	110.00	116.00	64.00	62.00	56.00	70.00	52.00
90.2	210.00	574.00	210.00	164.00	114.00	164.00	72.00	96.00
100.9	184.00	498.00	104.00	100.00	78.00	76.00	43.00	96.00
110.2	244.00	400.00	162.00	116.00	110.00	84.00	70.00	176.00
119.9	172.00	96.00	102.00	106.00	70.00	82.00	126.00	
129.9	110.00	146.00	140.00	58.00	108.00	72.00	72.00	82.00
140.1	98.00	140.00	134.00	68.00	78.00	86.00	130.00	212.00
150.2	124.00	108.00	100.00	54.00	100.00	80.00	86.00	76.00
159.9	126.00	108.00	150.00	92.00	104.00	60.00	74.00	58.00
170.9	100.00	168.00	114.00	68.00	88.00	68.00	60.00	92.00
179.9	108.00	98.00	136.00	80.00	70.00	72.00	66.00	96.00
190.0	171.00	104.00	138.00	40.00	50.00	92.00	56.00	72.00
199.8	200.00	80.00	86.00	48.00	86.00	80.00	52.00	36.00
210.2	71.00	46.00	60.00	18.00	62.00	92.00	60.00	56.00
219.8	88.00	60.00	80.00	48.00	74.00	58.00	46.00	32.00
230.1	54.00	64.00	60.00	38.00	90.00	64.00	42.00	50.00
239.6	32.00	48.00	48.00	30.00	96.00	50.00	22.00	22.00
250.0	54.00	42.00	42.00	26.00	70.00	34.00	22.00	28.00
260.4	42.00	40.00	56.00	48.00	76.00	44.00		18.00
270.6	58.00	42.00	58.00	34.00	56.00	46.00	30.00	32.00

ILLINOIS WATERWAY, TOTAL SOLIDS, mg/l

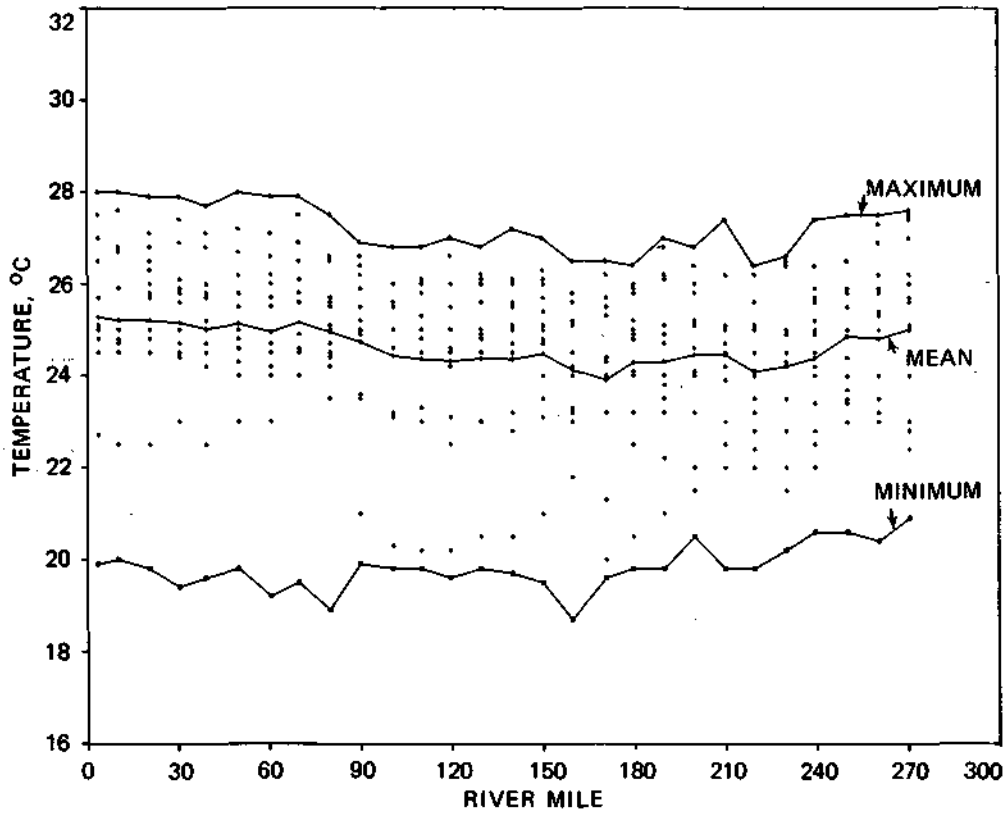
OATE	06/05/79	06/12/79	O6/19/79	06/26/79	07/10/79	07/17/79	09/11/79	09/18/79
MILE POINT								
3.6	516.00	603.00	567.00	529.00	508.00	435.00	449.00	452.00
10.3	554.00	626.00	578.00	503.00	502.00	506.00	460.00	453.00
20.7	556.00	614.00	634.00	509.00	519.00	478.00	483.00	459.00
30.6	582.00	696.00	634.00	555.00	504.00	482.00	465.00	465.00
39.3	650.00	818.00	707.00	592.00	526.00	491.00	478.00	534.00
50.0	618.00	887.00	630.00	600.00	521.00	492.00	473.00	582.00
60.8	560.00	762.00	615.00	548.00	511.00	477.00	485.00	556.00
70.0	602.00	837.00	656.00	558.00	518.00	504.00	513.00	488.00
80.2	580.00	601.00	607.00	533.00	516.00	469.00	491.00	495.00
90.2	698.00	******	679.00	635.00	561.00	560.00	495.00	543.00
100.9	668.00	975.00	582.00	581.00	536.00	487.00	503.00	543.00
110.2	742.00	884.00	633.00	590.00	579.00	510.00	539.00	627.00
119.9	676.00	606.00	574.00	579.00	562.00	472.00	575.00	
129.9	618.00	670.00	625.00	600.00	524.00	453.00	518.00	552.00
140.1	628.00	661.00	593.00	556.00	502.00	472.00	584.00	660.00
150.2	670.00	643.00	554.00	552.00	512.00	474.00	554.00	534.00
159.9	624.00	628.00	585.00	572.00	502.00	459.00	511.00	523.00
170.9	624.00	671.00	526.00	528.00	497.00	486.00	508.00	548.00
170.9	628.00	580.00	565.00	544.00	452.00	469.00	529.00	550.00
190.0	692.00	586.00	580.00	501.00	432.00	488.00	500.00	541.00
199.8	729.00	524.00	524.00	500.00	459.00	485.00	494.00	517.00
210.2	612.00	549.00	505.00	472.00	411.00	478.00	497.00	536.00
219.8	628.00	527.00	533.00	497.00	424.00	453.00	475.00	513.00
230.1	612.00	527.00	501.00	495.00	423.00	455.00	466.03	543.00
239.6	628.00	535.00	509.00	513.00	439.00	457.00	462.00	535.00
2S0.0	620.00	490.00	495.00	497.00	451.00	443.00	476.00	549.00
260.4	604.00	520.00	498.00	514.00	473.00	436.00		503.00
270.6	648.00	511.00	439.00	492.00	475.00	424.00	476.00	488.03

Appendix B-2. (Concluded)

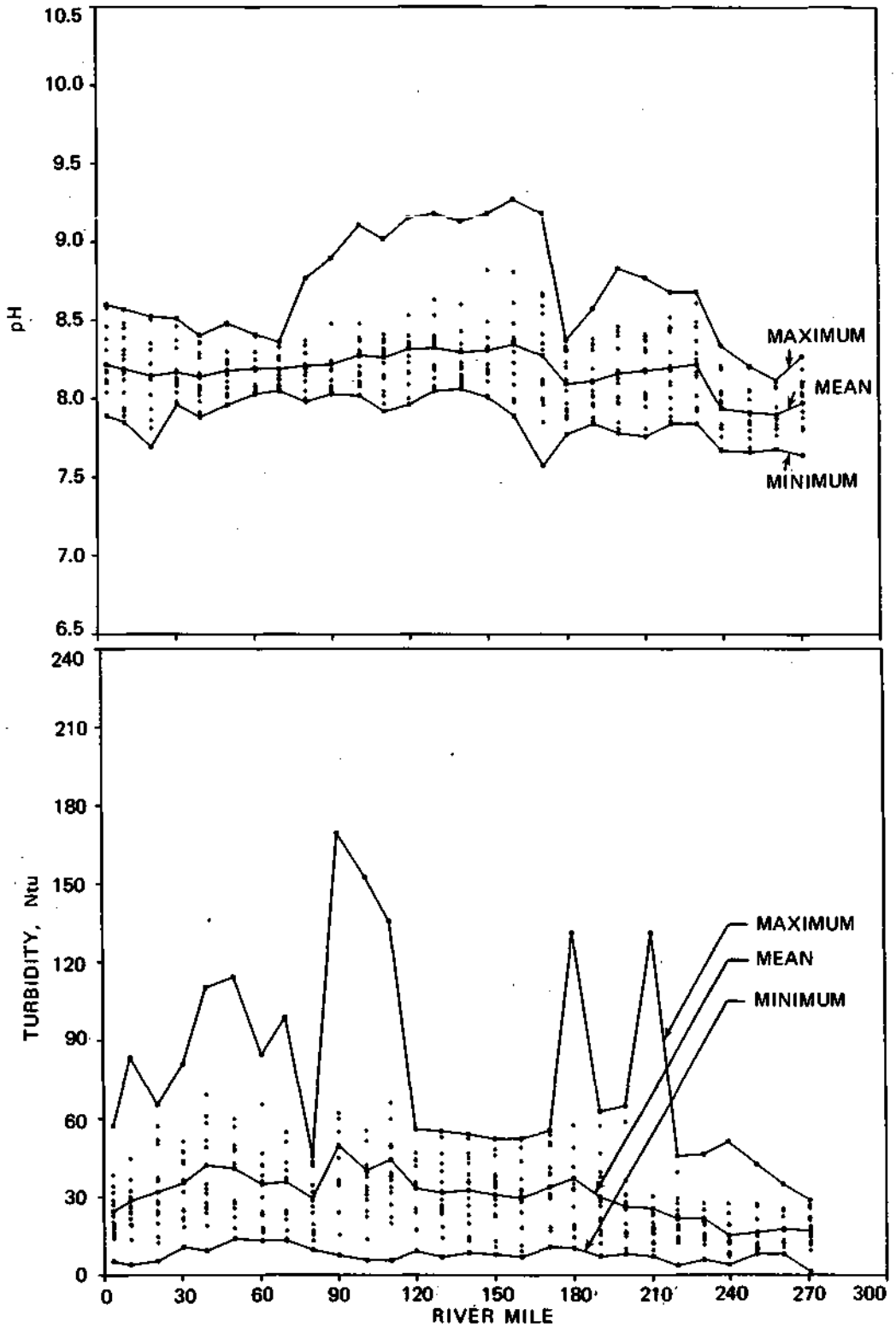
ILLINOIS WATERWAY, DISCHARGE, cfs

DATE	06/05/79	06/12/79	06/19/79	06/26/79	07/10/79	07/17/79	09/11/79	09/18/79
MILE POINT								
3.6	24830	10840	18670	20290	17240	13690	7951	6647
10.3	24090	11430	18600	19780	17000	13640	7910	6609
20.7	22930	12350	18490	19000	16630	13570	7846	6550
30.6	21770	13140	18340	18220	16240	13470	7775	6487
39.3	20800	13910	18240	17570	15930	13410	7722	6437
50.0	19610	14860	18130	16760	15540	13340	7656	6377
60.0	18400	15820	10010	15950	15160	12270	7590	6316
70.0	17380	16640	17910	15250	14830	13210	7534	6264
80.2	16240	17540	17800	14480	14460	13140	7472	6206
90.2	17440	18420	17390	11470	14590	12710	7112	5468
100.9	13940	16600	15520	9799	13110	11070	6373	5053
110.2	12460	16860	15310	9534	13170	10890	6251	5261
119.9	10910	17130	15080	9259	13230	10700	6123	5398
129.9	8521	16070	13460	8421	12900	10010	5874	5471
140.1	6895	16350	13220	8131	12970	9812	5740	5615
150.2	5881	16000	12750	7795	12730	9445	5635	5716
159.9	6078	15730	12520	7694	12410	9369	5657	5836
170.9	6225	14690	12930	7252	12940	10340	5945	6124
179.9	6486	14510	12490	7123	12480	10160	5977	6204
190.0	6780	14320	11990	6978	11950	9963	6014	6790
199.8	7065	14120	11520	6838	11440	9773	6049	6375
210.2	7147	13320	10570	6523	10790	9499	6030	6285
219.8	7462	13130	10110	6385	10290	9313	6064	6363
230.1	7362	12460	9090	6030	9397	8662	5700	6403
239.6	7639	12270	8626	5894	8901	8478	5735	6485
250.0	6472	8838	5745	4770	7031	7489	4b05	5886
260.4	6775	8636	5238	4621	6489	7287	4643	5977
270.6	6978	8295	4103	4423	5830	6991	4653	6056

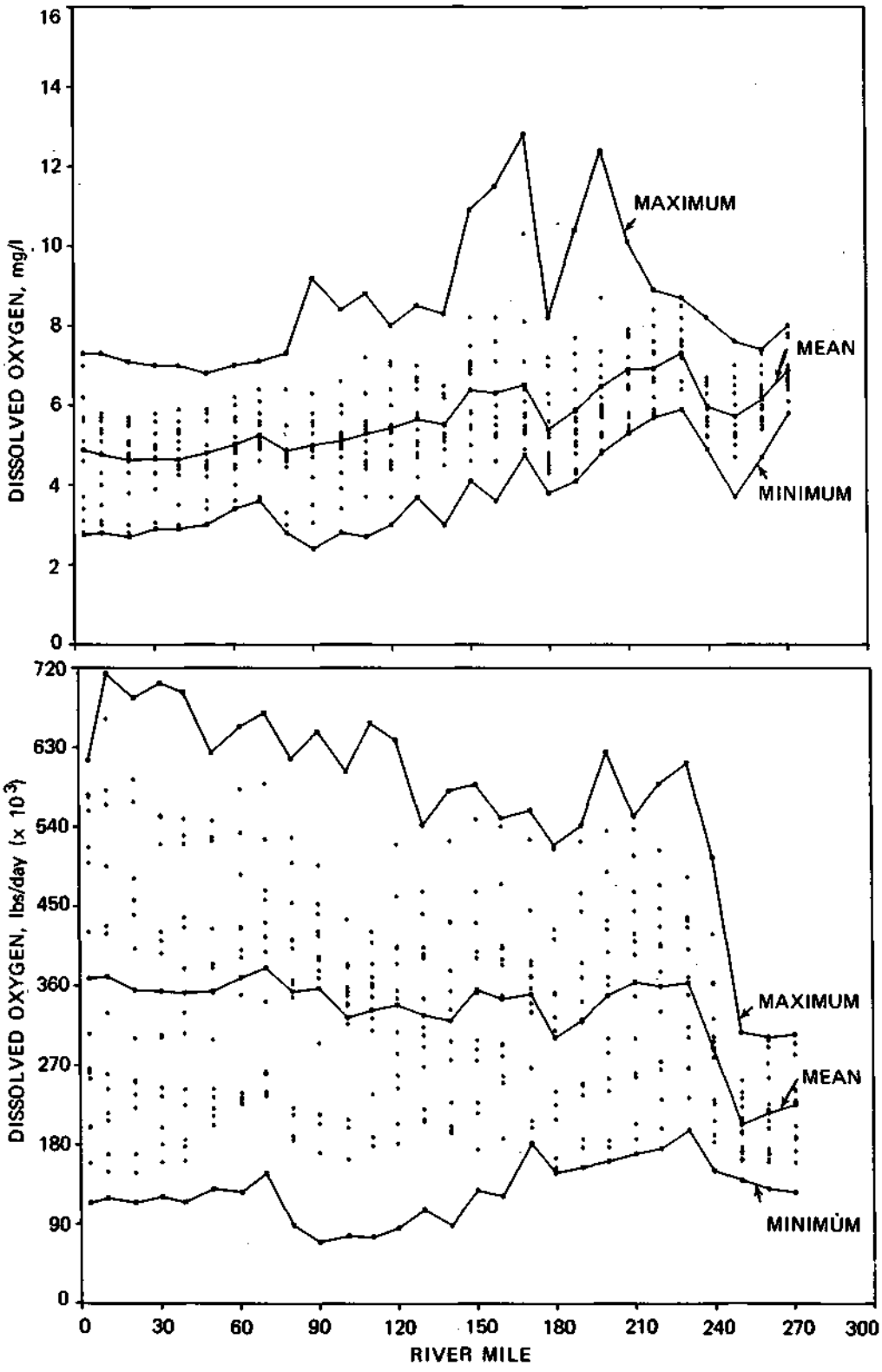
Appendix C. Means and Extremes of 1978-1979 Data for Illinois Waterway



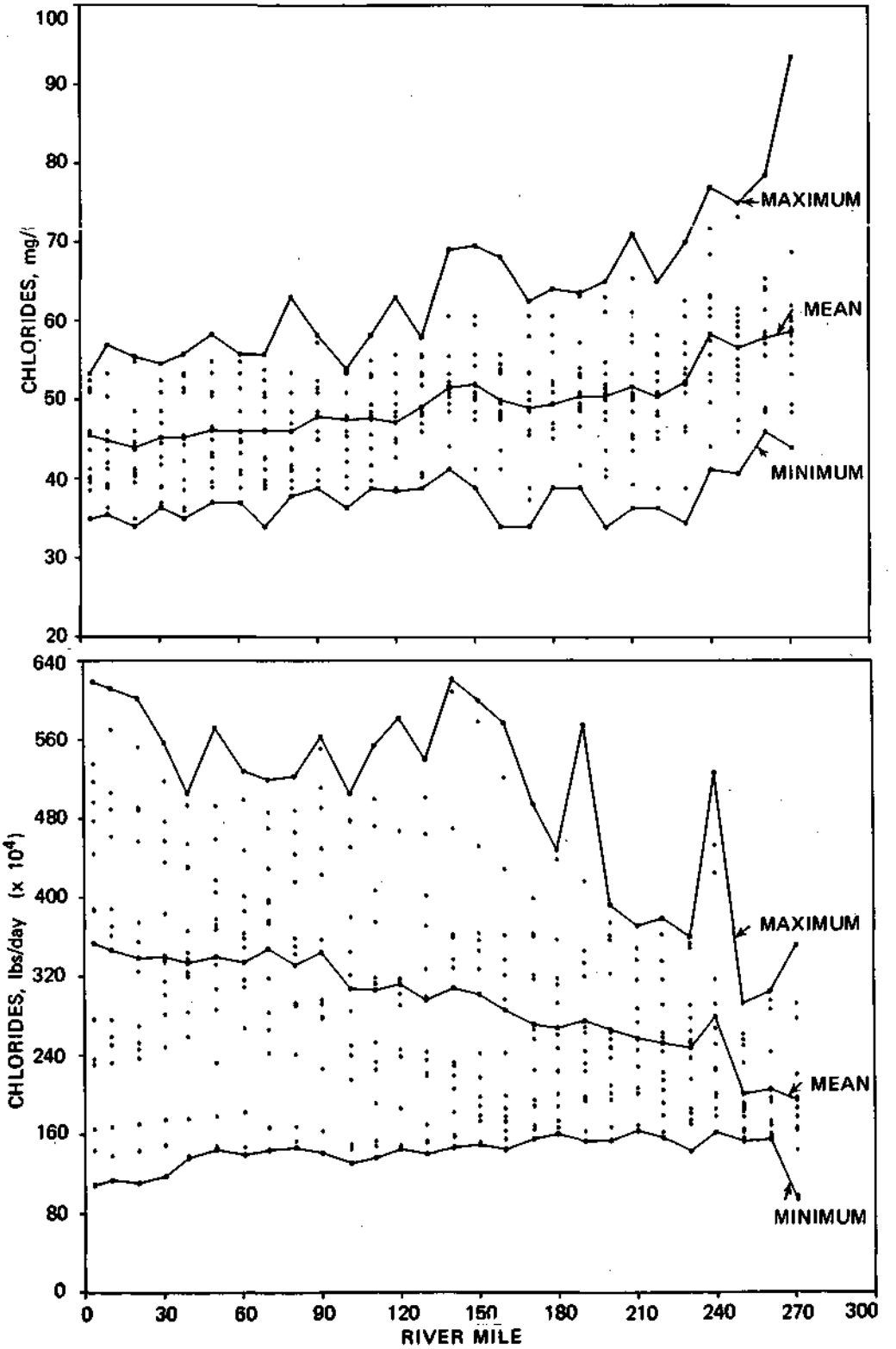
Appendix C. (Continued)



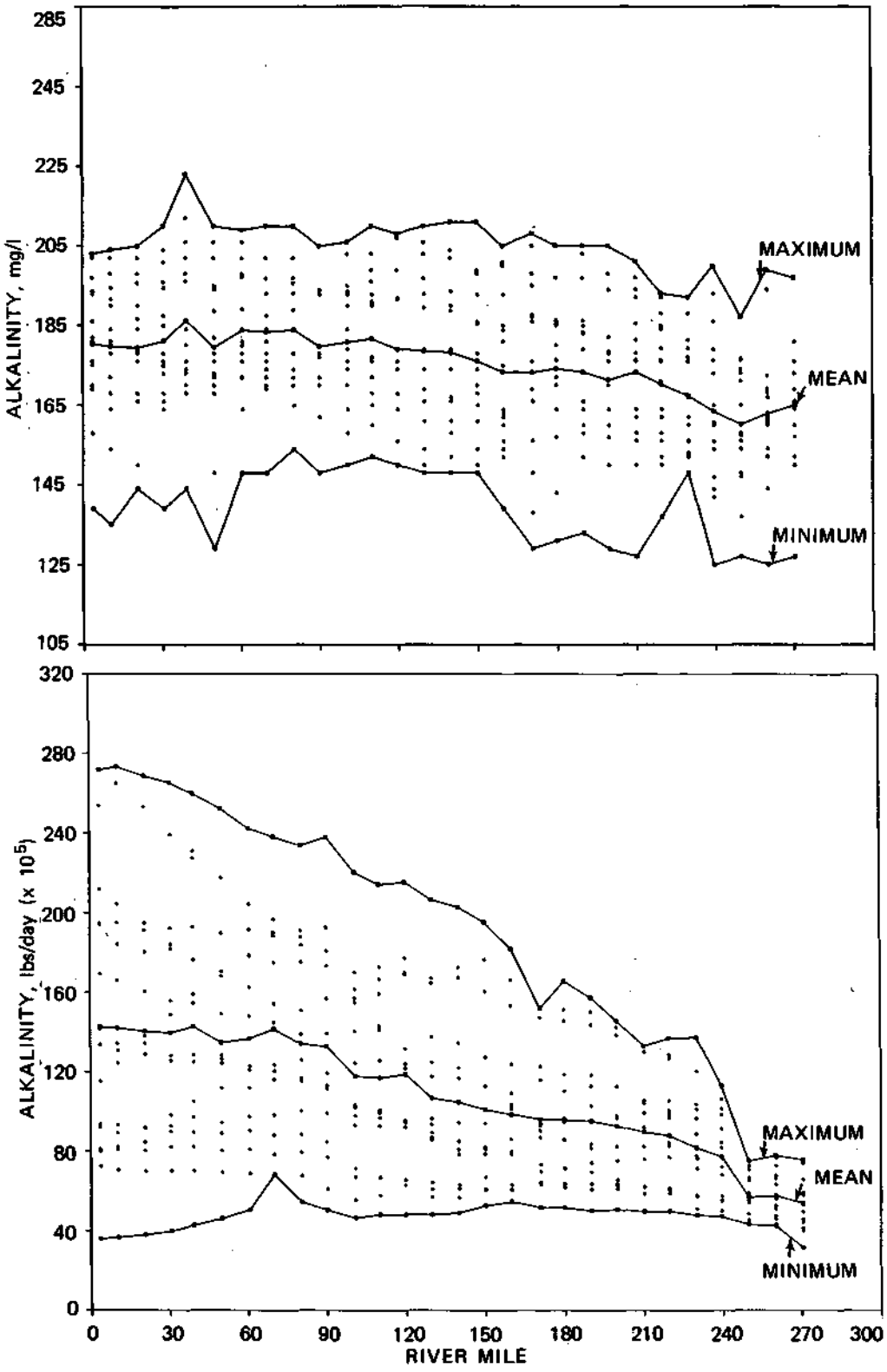
Appendix C. (Continued)

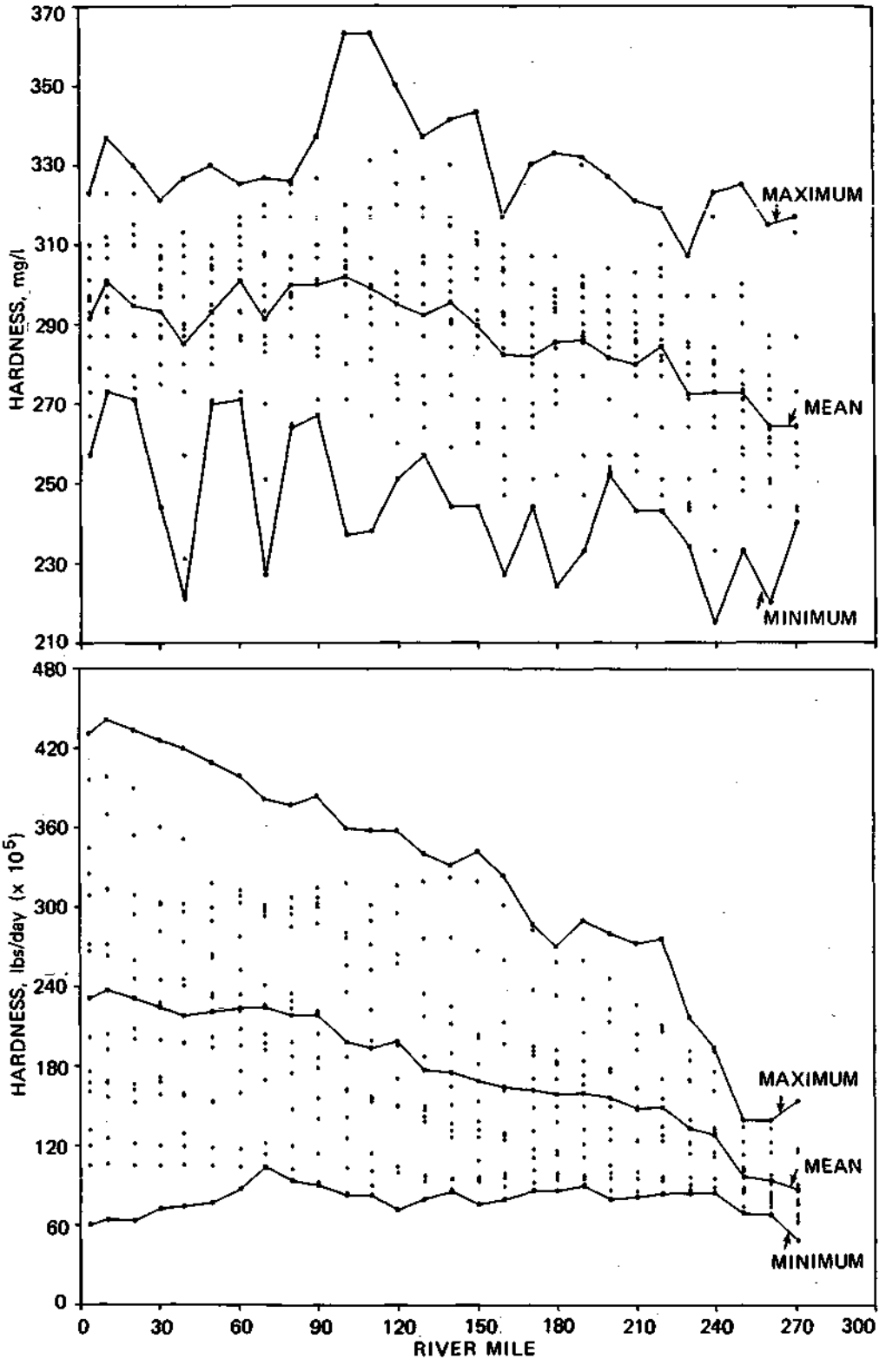


Appendix C. (Continued)

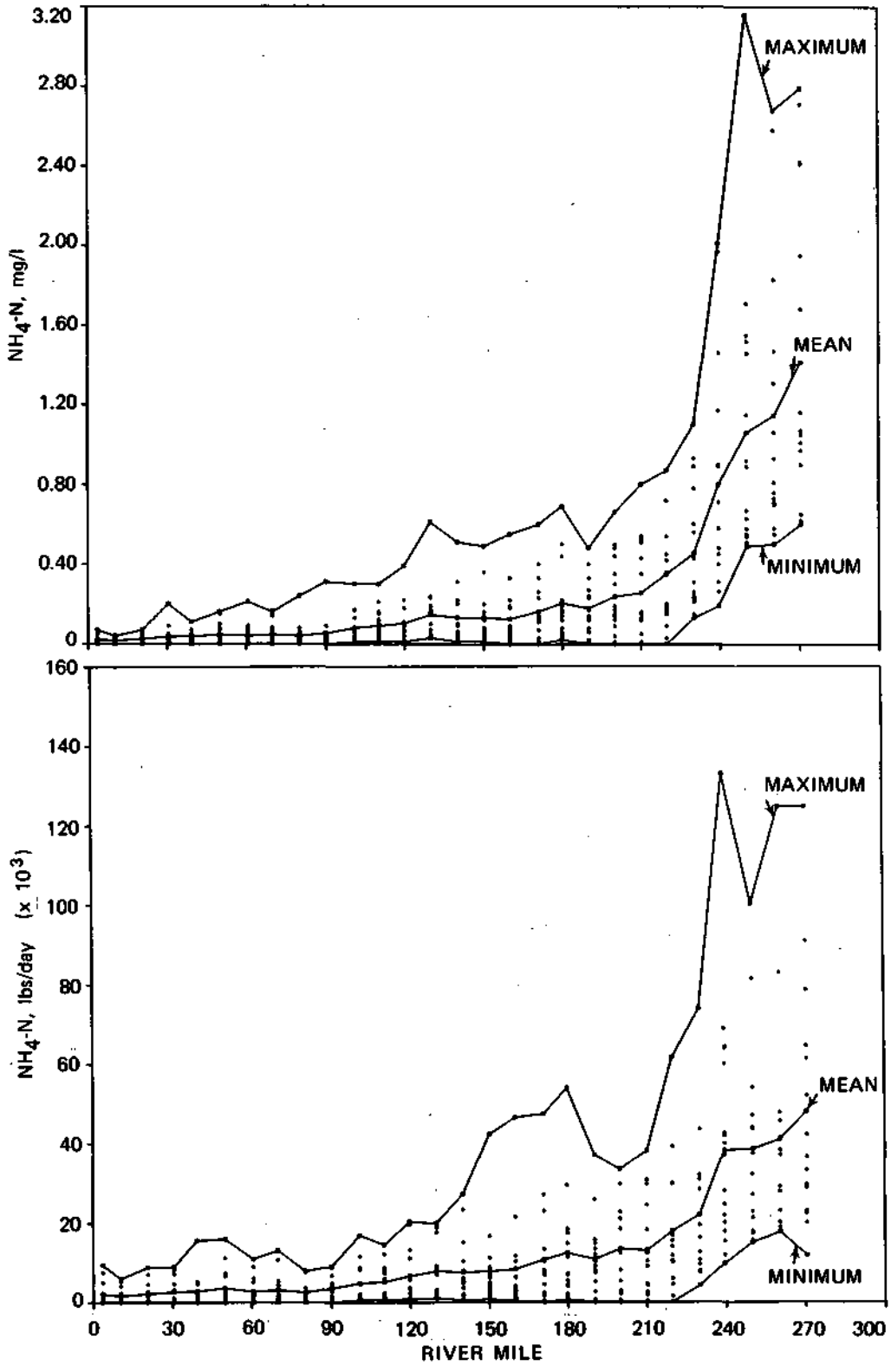


Appendix C. (Continued)

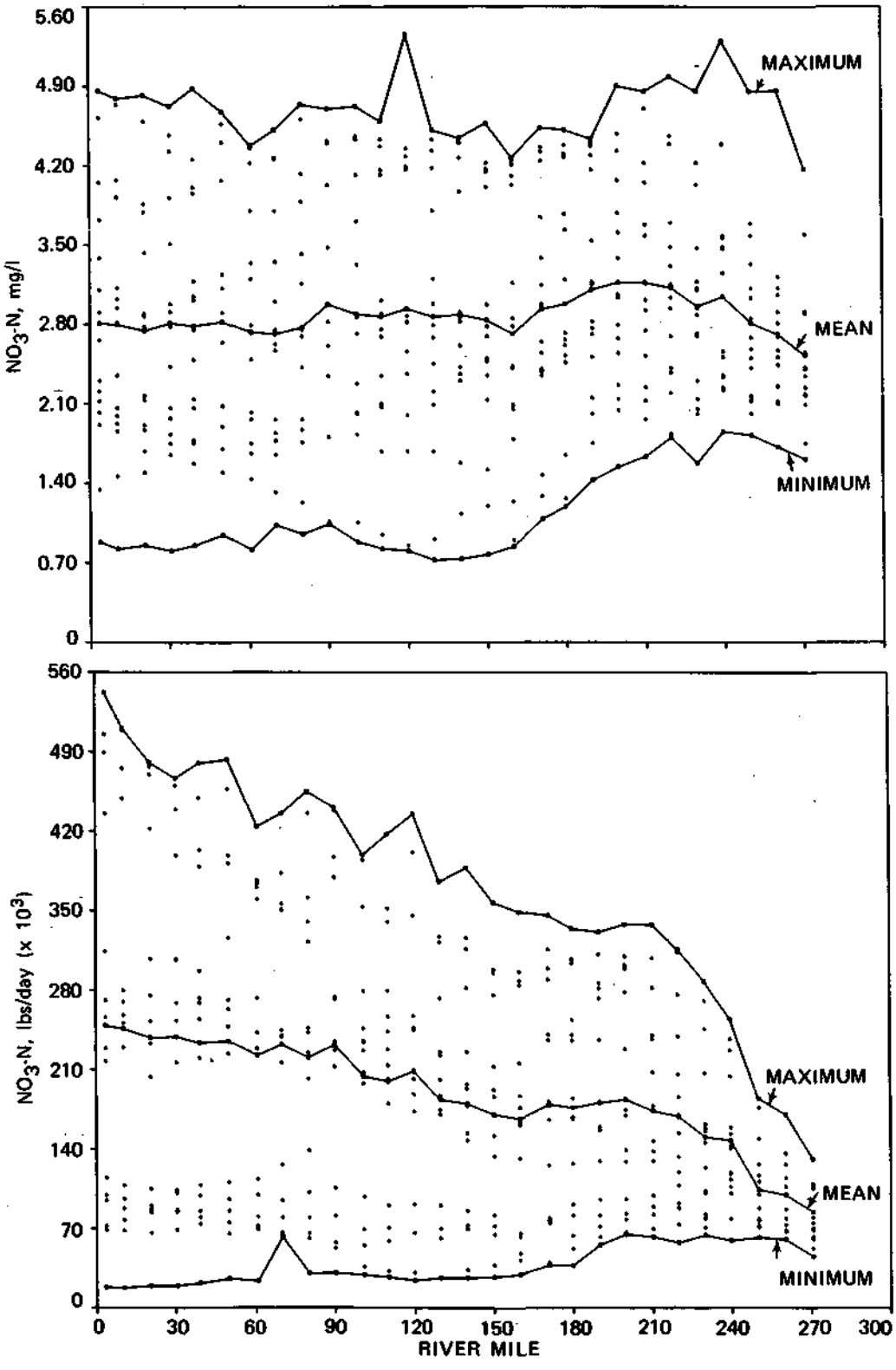



HARDNESS, mg/l
370
350
330
310
290
270
250
230
210
MAXIMUM
MEAN
MINIMUM
HARDNESS, lbs/day (x 10^5)
480
420
360
300
240
180
120
60
0
MAXIMUM
MEAN
MINIMUM
0
30
60
90
120
150
180
210
240
270
300
RIVER MILE

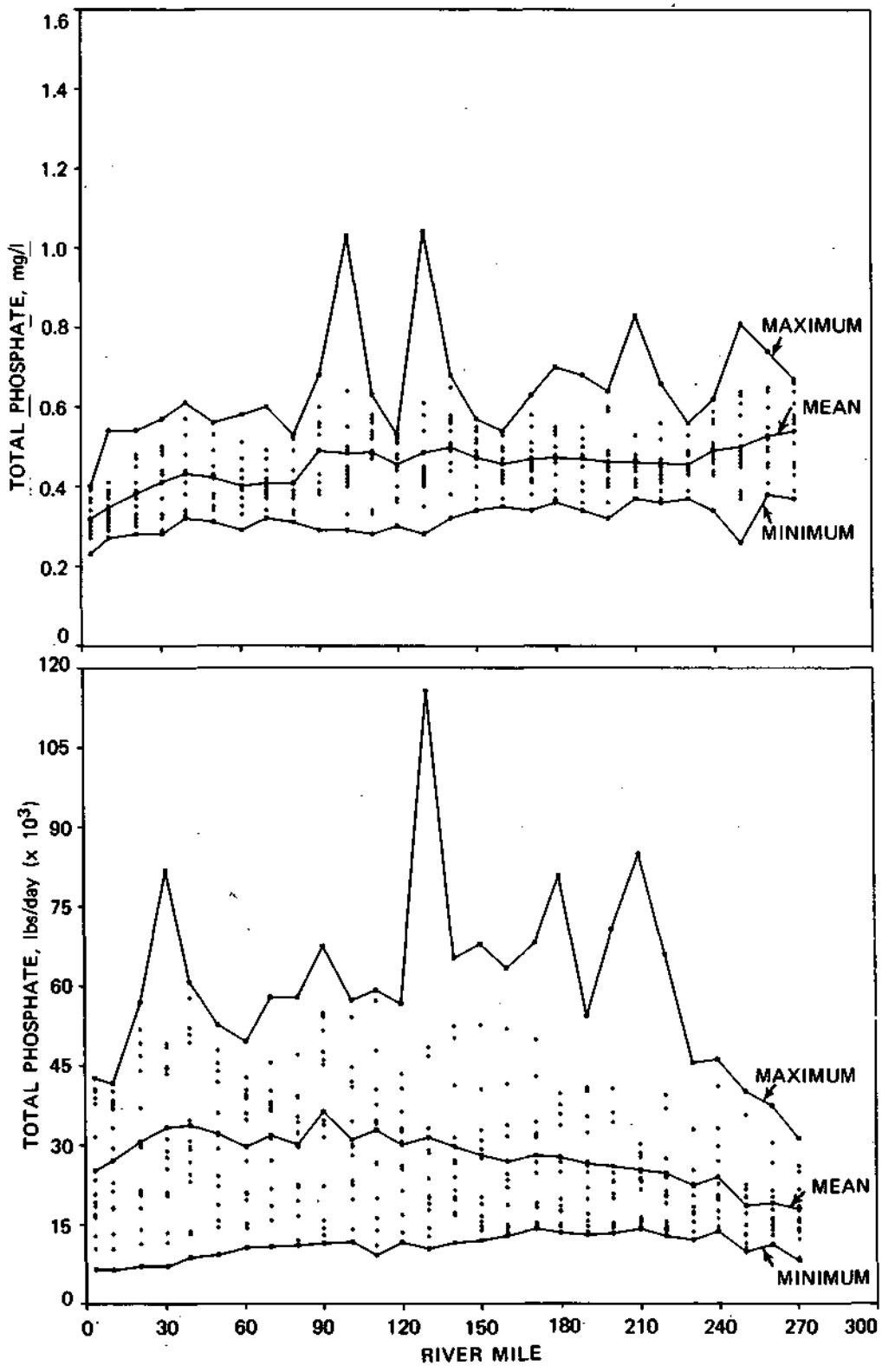
Appendix C. (Continued)



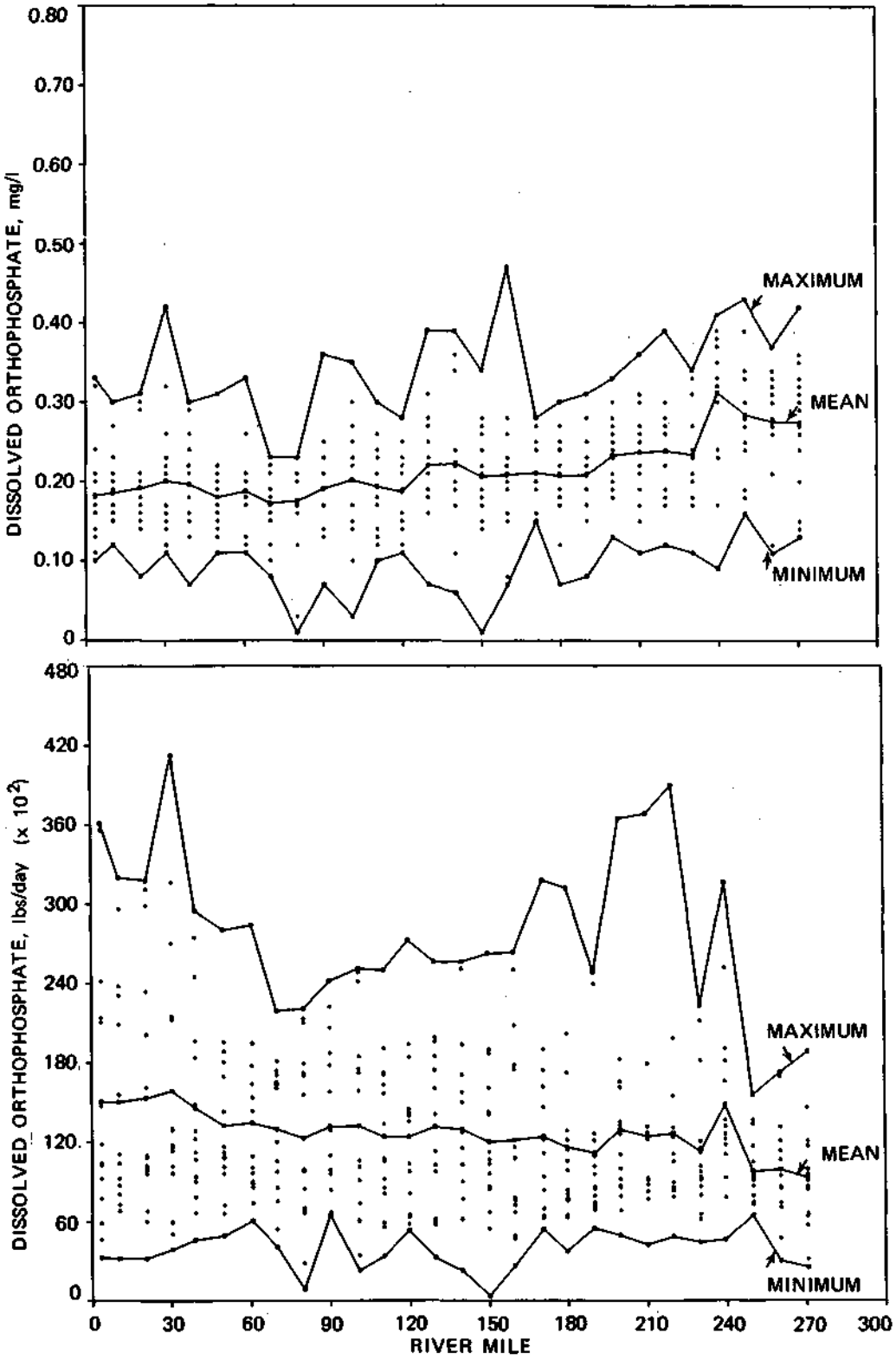
Appendix C. (Continued)



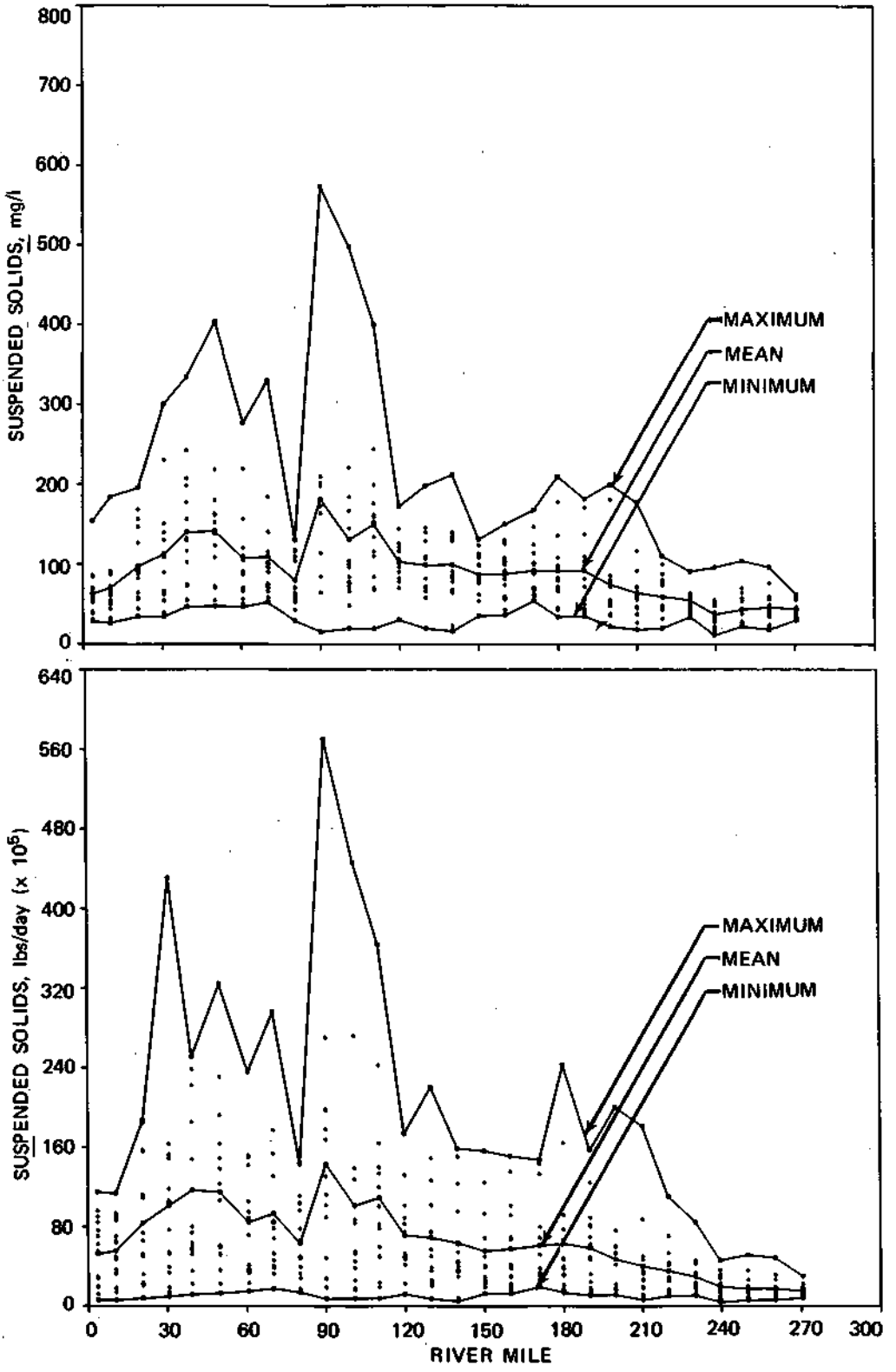
Appendix C. (Continued)



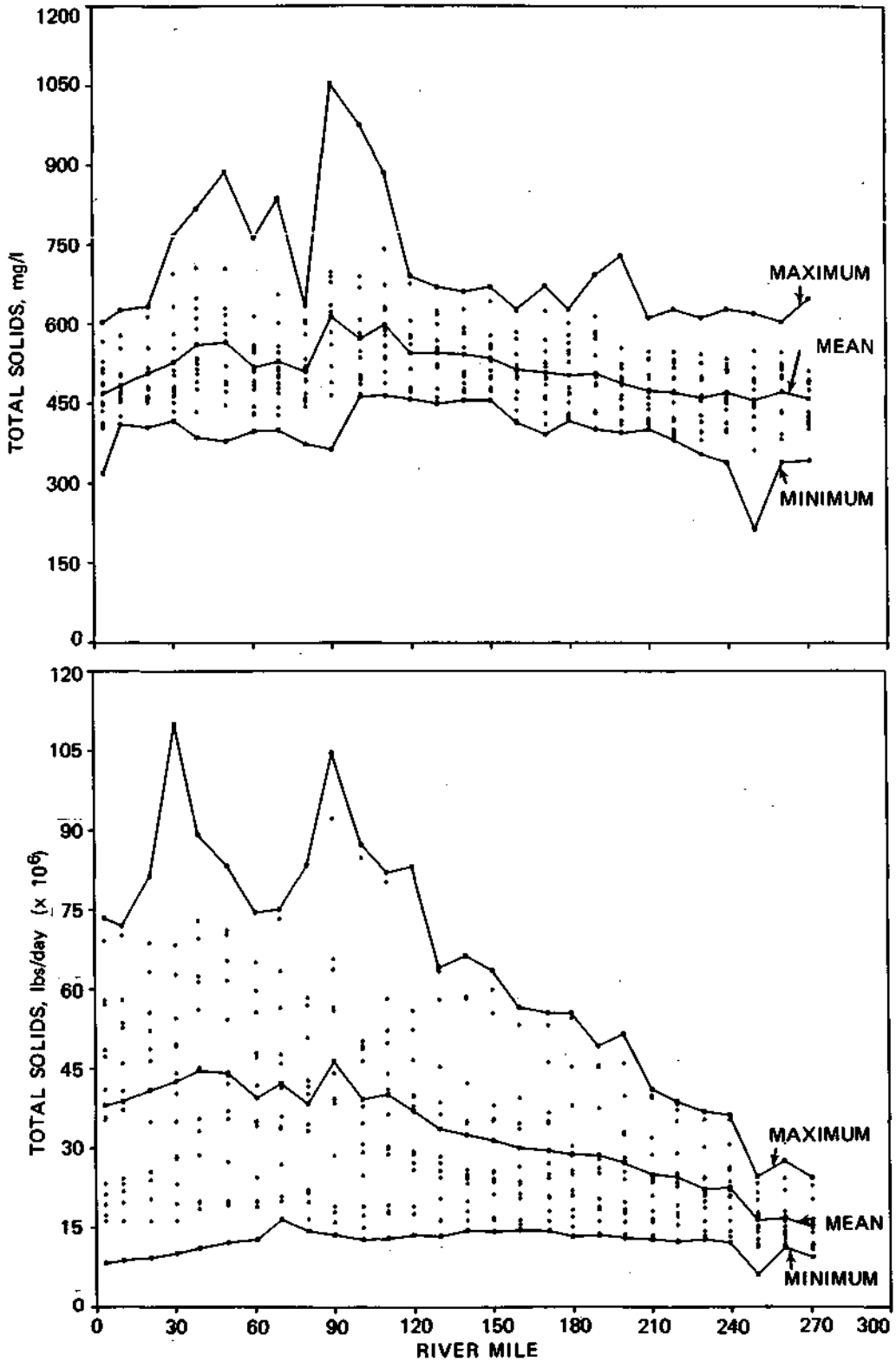
Appendix C. (Continued)



Appendix C. (Continued)



Appendix C. (Concluded)



Appendix D. Physical and Chemical Data for Major Tributaries

TRIBUTARIES TO THE ILLINOIS WATERWAY, TEMPERATURE, °C

DATE	06/05/79	06/12/79	06/19/79	06/26/79	07/10/79	07/17/79	09/11/79	09/18/79
MILE POINT								
23.1	27.00	23.80	28.00	24.80	28.40	27.60	24.50	21.50
83.7	26.20	23.50	25.50	25.00	25.40	26.50	24.00	20.10
95.4	24.60	23.00	25.00	26.00	27.70	27.10	24.50	23.50
120.5	25.20	23.20	25.50	24.20	25.80	25.60	24.50	22.00
147.8	23.10	23.90	22.30	26.60	23.80	21.40	18.50	0.00
209.2	23.10	23.00	20.20	22.60	24.80	22.80	20.50	16.50
226.3	26.20	23.40	22.50	24.90	23.70	23.40	25.00	18.00
239.7	24.20	22.00	23.00	24.10	25.00	24.40	23.10	18.40
263.6	25.30	22.50	22.20	23.90	24.60	23.00	23.50	20.00

TRIBUTARIES TO THE ILLINOIS WATERWAY, TURBIDITY, Ntu

DATE	06/05/79	06/12/79	05/19/79	06/26/79	07/10/79	07/17/79	09/11/79	09/18/79
MILE POINT								
23.1	23.40	167.90	33.30	41.70	21.70	33.90	22.00	15.50
B3.7	43.70	269.60	39.30	31.70	35.10	31.50	32.50	23.81
95.4	18.00	154.10	29.20	26.50	20.40	24.10	13.10	3.50
120.5	59.60	698.90	563.50	52.60	47.20	117.10	37.80	30.10
147.8	11.80	36.30	41.90	21.00	30.20	32.90	17.20	10.00
209.2	22.40	42.20	546.10	20.10	34.90	16.90	6.10	11.80
226.3	31.50	39.60	43.10	21.70	39.90	30.60	8.60	16.80
239.7	22.60	30.70	30.80	18.20	20.90	23.50	19.70	22.90
263.6	12.00	17.30	17.90	25.20	29.10	37.80	6.30	9.00

TRIBUTARIES TO THE ILLINOIS WATERWAY, DISSOLVED OXYGEN, mg/l

DATE	06/05/79	06/12/79	06/19/79	06/26/79	07/10/79	07/17/79	09/11/79	09/18/79
MILE POINT								
23.1	8.10	4.80	2.70	2.30	7.10	.60	6.60	5.00
83.7	5.10	5.10	6.50	10.20	5.30	7.80	6.60	5.30
95.4	8.80	6.80	9.30	12.60	14.70	14.80	11.50	10.00
120.5	6.50	5.30	6.00	6.70	6.00	5.80	4.90	7.70
147.8	3.70	7.80	9.70	8.30	7.20	7.80	10.50	0.00
209.2	6.10	7.10	7.30	7.80	7.70	8.50	8.10	7.70
226.3	7.80	7.10	8.20	7.70	7.60	7.40	15.50	9.90
239.7	15.20	8.50	8.30	10.80	11.40	11.20	11.10	10.00
263.6	8.40	6.60	7.20	6.40	8.60	6.80	8.90	9.50

TRIBUTARIES TO THE ILLINOIS WATERWAY, CHLORIDE, mg/l

DATE	06/05/79	06/12/79	06/19/79	06/26/79	07/10/79	07/17/79	09/11/79	09/18/79
MILE POINT								
23.1	14.50	9.50	11.00	11.50	12.10	9.70	3.40	1.50
83.7	16.00	15.00	18.50	23.40	17.00	16.30	13.60	7.80
95.4	28.00	26.50	32.40	18.90	74.50	29.60	?9.30	25.70
120.5	20.50	19.50	22.30	21.40	18.40	233.00	19.90	13.40
147.8	21.50	21.00	18.00	17.90	17.90	15.00	16.00	16.00
209.2	22.50	26.00	20.50	20.90	18.40	20.40	13.10	9.70
226.3	29.50	25.50	30.00	31.70	17.20	21.60	26.20	28.60
239.7	40.00	34.50	39.00	41.40	40.20	50.40	38.30	49.00
263.6	35.00	27.00	30.00	28.90	17.50	23.80	23.30	33.50

TRIBUTARIES TO THE ILLINOIS WATERWAY, pH

DATE	06/05/79	06/12/79	06/19/79	06/26/79	07/10/79	07/17/79	09/11/79	09/18/79
MILE POINT								
23.1	8.24	7.82	7.93	8.15	7.91	7.96	7.95	8.06
83.7	7.93	7.94	8.15	8.67	8.09	8.40	7.93	7.86
95.4	8.41	8.13	8.94	8.63	8.83	8.97	8.48	3.63
120.5	8.15	7.86	8.01	8.36	8.17	8.10	8.24	7.85
147.8	8.23	8.13	8.49	8.28	8.41	7.99	8.20	8.11
209.2	8.10	8.12	8.10	8.26	8.20	8.19	8.35	8.11
226.3	8.34	8.03	8.28	8.30	7.94	8.15	8.40	8.55
239.7	8.52	8.37	8.48	8.61	8.74	9.06	8.70	8.78
263.6	8.31	8.09	8.13	8.20	8.07	8.09	7.98	3.26

Appendix D. (Continued)

TRIBUTARIES TO THE ILLINOIS WATERWAY, ALKALINITY, mg/l

OATE	06/05/79	06/12/79	06/19/79	06/26/79	07/10/79	07/17/79	09/11/79	09/18/79
MILE POINT								
23.1	288.00	152.00	234.80	275.20	264.00	284.00	22S.00	259.00
83.7	202.00	145.00	181.30	185.40	209.00	210.00	192.00	176.00
95.4	238.00	194.00	225.40	201.10	235.00	212.00	177.00	229.00
120.5	242.00	138.00	181.70	249.30	210.00	209.00	193.00	223.00
147.8	239.00	214.00	232.80	230.70	243.00	181.00	217.00	255.00
209.2	244.00	236.90	230.70	251.30	251.00	246.00	293.00	304.00
226.3	226.00	206.00	222.90	181.30	179.00	190.00	174.00	195.00
239.7	185.00	230.70	214.20	168.90	229.00	169.00	245.00	218.00
263.6	202.00	192.80	208.10	218.40	214.00	204.00	186.00	188.00

TRIBUTARIES TO THE ILLINOIS WATERWAY, HARDNESS, mg/l

DATE	06/05/79	06/12/79	06/19/79	06/26/79	07/10/79	07/17/79	09/11/79	09/18/79
MILE POINT								
23.1	340.70	203.00	290.00	320.00	313.00	320.00	279.00	311.00
83.7	265.30	218.00	254.00	241.30	267.00	261.00	253.00	271.00
95.4	320.00	287.00	286.70	274.00	312.00	280.00	259.00	293.00
120.5	374.00	219.00	286.70	380.00	319.00	333.00	340.00	369.00
147.8	336.70	319.00	326.00	314.70	361.00	270.00	287.00	297.00
209.2	340.00	358.70	306.70	346.00	333.00	327.00	326.00	359.00
226.3	380.00	353.30	372.70	328.00	303.00	313.00	320.00	353.00
239.7	280.00	326.70	298.70	264.00	320.00	260.00	332.00	313.00
263.6	427.00	398.70	422.00	414.70	360.00	357.00	367.00	374.00

TRIBUTARIES TO THE ILLINOIS WATERWAY, AMMONIA-NITROGEN, mg/l

OATE	06/05/79	06/12/79	06/19/79	06/26/79	07/10/79	07/17/79	09/11/79	09/13/79
MILE POINT								
23.1	.06	.22	.07	.01	.01	.05	.03	.05
83.7	.10	.22	.09	.03	.01	.01	.03	.05
95.4	.04	.16	.04	.06	0.00	.01	.03	.03
120.5	.01	.09	.09	.08	.04	.16	.03	.07
147.8	.04	.09	.08	.11	.01	.16	.04	.07
209.2	.12	.19	.10	.13	.04	.10	.14	.39
226.3	.07	.17	.03	.09	.07	.07	.06	.09
239.7	.05	.08	.03	.08	.02	.03	0.00	.15
263.6	.07	.11	.04	.11	.03	.16	0.00	.17

TRIBUTARIES TO THE ILLINOIS WATERWAY, N03-N, mg/l

DATE	06/05/79	06/12/79	06/19/79	06/26/79	07/10/79	07/17/79	09/11/79	09/18/79
MILE POINT								
23.1	.16	1.86	.35	.19	.05	.10	.10	.08
83.7	3.18	3.00	5.02	3.60	1.42	.28	.30	.10
95.4	4.68	5.96	3.34	2.85	2.22	1.09	.09	.10
120.5	6.08	5.66	7.69	7.69	4.46	5.14	.09	.18
147.8	5.58	9.04	5.86	4.02	4.48	5.51	1.68	1.35
209.2	6.14	12.13	8.30	7.15	5.34	3.03	1.78	.94
226.3	7.98	10.97	9.90	6.58	11.42	10.23	2.85	.96
239.7	1.32	3.13	2.56	1.30	1.43	.16	.83	.19
263.6	6.20	8.92	7.33	9.07	9.92	6.58	2.27	1.53

TRIBUTARIES TO THE ILLINOIS WATERWAY, TOTAL PHOSPHATE, mg/l

DATE	06/05/79	06/12/79	06/19/79	06/26/79	07/10/79	07/17/79	09/11/79	09/18/79
MILE POINT								
23.1	.21	.34	.23	.31	.22	.36	.24	.25
83.7	.32	.64	.29	.29	.27	.26	.21	.21
95.4	.37	.70	.49	.44	.71	.52	.30	.29
120.5	.45	2.74	2.92	.40	.32	.40	.32	.35
147.8	.15	.31	.17	.20	.24	.18	.14	.10
209.2	.16	.35	1.74	.19	.23	.2ft	.16	.19
226.3	.26	.27	.43	.16	.30	.24	.14	.24
239.7	.23	.37	.30	.27	.25	.34	.31	.36
263.6	.07	.11	.10	.09	.13	.19	.06	.06

Appendix D. (Concluded)

TRIBUTARIES TO THE ILLINOIS WATERWAY, DISSOLVED PHOSPHATE, mg/l

DATE	06/05/79	06/12/79	05/19/79	06/26/79	07/10/79	07/17/79	09/11/79	09/18/79
MILE POINT								
23.1	.03	.01	.06	.06	0.00	.02	.03	.04
83.7	.05	.04	.11	.04	.02	0.00	0.00	.02
95.4	.15	.12	.15	.11	.33	.15	.07	.10
120.5	.01	.02	.10	.12	.07	.07	.02	.02
147.8	.09	.05	.06	.10	.02	.06	.01	.03
209.2	.02	.16	.05	.10	.03	.07	.07	.03
226.3	.05	.16	.11	.04	.10	.15	.02	.06
239.7	0.00	.12	.03	.01	.08	.01	.11	.06
263.6	0.00	.04	.01	.02	.01	.05	0.00	.02

TRIBUTARIES TO THE ILLINOIS WATERWAY, SUSPENDED SOLIDS, mg/l

DATE	06/05/79	06/12/79	06/19/79	06/26/79	07/10/79	07/17/79	09/11/79	09/18/79
MILE POINT								
23.1	72.00	168.00	76.00	82.00	128.00	94.00	63.00	50.00
83.7	192.00	736.00	156.00	108.00	140.00	132.00	110.00	78.00
95.4	110.00	402.00	172.00	122.00	144.00	156.00	104.00	52.00
120.5	298.00	2468.00	2448.00	184.00	168.00	300.00	166.00	136.00
147.8	52.00	238.00	178.00	78.00	100.00	112.00	112.00	83.00
209.2	59.00	174.00	2034.00	80.00	144.00	64.00	15.00	50.00
226.3	87.00	84.00	322.00	70.00	140.00	72.00	48.00	55.00
239.7	78.00	126.00	152.00	74.00	90.00	98.00	66.00	90.00
263.6	18.00	36.00	50.00	48.00	68.00	100.00	16.00	42.00

TRIBUTARIES TO THE ILLINOIS WATERWAY, TOTAL SOLIDS, mg/l

DATE	06/05/79	06/12/79	06/19/79	06/26/79	07/10/79	07/17/79	09/11/79	09/18/79
MILE POINT								
23.1	511.00	492.00	449.00	471.00	430.00	467.00	406.00	401.00
83.7	541.00	374.00	494.00	329.00	491.00	452.00	437.00	398.00
95.4	543.00	794.00	513.00	475.00	668.00	522.00	464.00	434.00
120.5	830.00	2311.00	2761.00	678.00	583.00	739.00	639.00	625.00
147.8	516.00	663.00	551.00	484.00	562.00	468.00	463.00	353.00
209.2	506.00	653.00	2400.00	496.00	527.00	463.00	850.00	473.00
226.3	595.00	577.00	330.00	504.00	517.00	507.00	488.00	541.00
239.7	484.00	568.00	547.00	450.00	505.00	499.00	508.00	532.00
263.6	635.00	607.00	646.00	619.00	536.00	591.00	553.00	555.00

TRIBUTARIES TO THE ILLINOIS WATERWAY, DISCHARGE, cfs

DATE	06/05/79	06/12/79	06/19/79	06/26/79	07/10/79	07/17/79	09/11/79	09/18/79
MILE POINT								
23.1	48	91	40	33	28	38	11	8
83.7	245	435	237	182	105	121	20	13
95.4	1798	2128	1617	1362	1153	1436	598	439
120.5	793	1333	1383	554	395	502	117	68
147.8	267	367	231	135	118	228	47	33
209.2	221	603	436	166	109	72	57	181
226.3	363	476	513	207	351	451	401	55
239.7	1469	3229	2374	975	1323	788	1167	689
263.6	93	142	638	51	127	93	26	9